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Thread Blights.

BY

T. Petch, B.A., B.Sc.

WITH NINE PLATES.

The name Thread Blight is applied by the European planter in the Eastern Tropics to white mycelium which runs in well-defined, narrow strands, with the appearance of coarse, white thread, along the branches and over the leaves of plants at some height from the ground. It was first applied to white mycelium found on tea in Northern India, but the term has since been extended to similar white, or coloured, mycelia in Ceylon, Malaya, Java, Africa, and the West Indies.

As understood by the planter, a Thread Blight is a conspicuous white mycelium, which can be seen on the bush or tree from a distance of several yards. Repent mycelia which can be detected only on close examination are not Thread Blights to him. *Corticium Koleroga*, for example, which causes Black Rot of coffee in India, and the similar *Corticium* which causes Black Rot of coca in Ceylon (Plate II), are not Thread Blights, because the hyphae on the stem form a thin film which is practically invisible, when fresh, and the planter only sees the effect on the leaf. Pink disease (*Corticium salmonicolor* B. and Br.), again, is not a Thread Blight, because, although it may produce hyphae which run over the surface of the bark, these are diffuse and form almost a continuous sheet with broad, anastomosing, denser bands here and there. The distinction, however, is not a scientific one, nor does it hold good for any definite group of fungi. On Ceylon experience one would say that the Corticiums do not, in general, form Thread Blights, but three species from Java, viz., *Corticium Theae*, *Corticium Gardeniae* (?), and an unnamed species on tea, have a distinct barren cord running along the stem of the host plant.

The original Thread Blight, which occurs on tea in Northern India, was sent to Berkeley, and was noted by him in the Gardeners' Chronicle, No. 24, June 14, 1873, pp. 810, 811, as follows :—

"The Tea plantations in India have lately been much troubled with a parasite which has been named Thread Blight.....

It may, however, be described provisionally as *Corticium repens* B., hypothallo filiformi repente albo, hymenio pallide rufo. Spreading widely over living shrubs, on which it forms white, linear, creeping threads, which run off from the bark to the leaves; hymenium of a very pale rufous colour. At present it has not been observed apparently in its most perfect state, at least we have been unable to detach the spores so as to ascertain with certainty their form or nature."

Berkeley published another note on the subject in 1875, in which he stated that he had specimens on *Andrachne trifoliata*, as well as on tea. He gave a rough figure of the thread, and described it as "externally clothed with flexuous threads, in which, as far as we have ascertained, there are no joints." He did not make use of the name *Corticium repens* in this second note.

Unfortunately, Berkeley's specimen of *Corticium repens* does not appear to be included in his herbarium in Herb. Kew, and it is not possible to say definitely which species he had. There are at least two species of Thread Blight on tea in India, one of which is epiphytic and the other parasitic. As specimens were sent to Berkeley with the statement that the fungus was parasitic on tea, it might be assumed that he had the parasitic species, but, as will be evident later, that assumption may be incorrect.

The earlier literature relating to tea in India contains numerous references to Thread Blight, but most of them do not add anything to our knowledge of the fungus. Cunningham published a note on it in 1897, and stated that it occurred on tea in Darjeeling, and in the Andaman Islands. His description appears to be that of the parasitic North Indian Tea Thread Blight, but he did not describe any peculiarities in the threads, merely stating that they were "rhizomorphic aggregates of filaments."

In 1898, Massee described an Indian Thread Blight, said to be parasitic on tea, in a paper on Tea Blights. He gave no particulars of the external mycelium, except that the hyphae were 2-3 μ in diameter, vaguely branched, and sparsely septate. On a specimen submitted to him there occurred a small *Stilbum*, which Massee regarded as the fructification and named *Stilbum nanum*. This *Stilbum*, however, is a common saprophyte on dead twigs, and has no relation to the Thread Blight. Massee figured the *Stilbum* arising from expansions of the thread, but in the type of *Stilbum nanum* in Herb. Kew (Watt 11958), the *Stilbum* is on a twig which does not bear any Thread Blight. It is on a tea pruning which had been lying for some time on the ground. This *Stilbum* is red, not pale yellow as stated by Massee ; and it is most probably identical with *Stilbella Heveae* Zimm. and *Stilbella Theae* Bernard. The account given by Massee of the penetration of the my-

celium into the wood may possibly refer to the mycelium of the *Stilbum*. His suggestion that Thread Blight is a root fungus, and spreads up the stem from the ground, is without foundation, but there is a root disease of tea, caused by *Polyporus interruptus*, in which the mycelium of the fungus may spread upwards over the stems of the bush, in a manner exactly similar to Thread Blight.

It is doubtful whether Massee had seen the Indian Thread Blight at the time he described *Stilbum nanum*. The type specimen of the latter contains one twig only, the one figured by him, and it does not bear any Thread Blight. Consequently it is not possible to state to which Thread Blight Massee intended to apply the name *Stilbum nanum* in 1898. The fact that he made no mention of any peculiar cells on the hyphae points to the epiphytic species, but on the other hand it is by no means clear that he examined the cord of Thread Blight. There are, however, in the cover of *Stilbum nanum* in Herb. Kew, specimens of Indian Thread Blight, collected in 1900, which were assigned by Massee to *Stilbum nanum*. These later specimens are the epiphytic species, and they are of great interest in that they bear a fructification, a *Marasmius*, which demonstrates that this species is identical with the common Thread Blight of Tea in Ceylon.

Consequently, as far as any evidence exists, the name *Stilbum nanum* was applied to the epiphytic species which had already been named from Ceylon, twenty-five years previously. Up to the end of 1920, there was no specimen of the parasitic Indian Thread Blight discoverable at Kew or the British Museum.

In 1904, Zimmermann described a Thread Blight which occurred on coffee in Java. From his description it was evidently similar to the parasitic Indian Tea Thread Blight. He gave it the name of " Spinnenwebeziekte" from the appearance of the mycelium on the leaves. It is more or less characteristic of this class of Thread Blights that the thread divides, when it runs over a leaf, into a number of similar threads radiating from the leaf stalk, which become united laterally by thinner strands and separate hyphae into a continuous sheet.

Zimmermann stated that the thread was composed of parallel hyphae, with others which were more or less flexuose and furnished with numerous short lateral branches. He was unable to make any suggestion as to the function of these branches, but did not consider that they could serve to fasten the thread to the leaf, as they occurred in great numbers on hyphae which were not in contact with the leaf but extended freely into the air. He also found, between the hyphae of the thread, peculiar bodies which he named " anker " cells. These, in general, have long conical points at either end, and two or three similar points arranged in a circle round the middle ; they may be terminal

or intercalary. Zimmermann stated that he named them "anker" cells, because of their shape,—an explanation which leaves the precise meaning of "anker" somewhat in doubt.

In Ceylon, a Thread Blight on nutmeg was known in 1900, but was not recorded until 1905. Since then, the same Thread Blight has been found on tea, and other species on other plants. Photographs of the first-named species were published in the Tropical Agriculturist XXVI (April, 1906).

In the West Indies, a Thread Blight which occurs on Cacao was described by Lewton Brain in 1905. It had been found in St. Lucia and Trinidad. It occurred in dark brown strands, running irregularly up and down the twigs, and branching irregularly, but especially in the neighbourhood of a leaf or bud. When young the strands are white and thin, but they darken and become thicker later. Occasional swellings were found on the threads of the Trinidad specimen : these were at first taken to be reproductive bodies, but on examination were found to be merely masses of mycelium.

Lewton Brain stated that when the thread reached a bud, it spread out and branched, so that the bud became covered with a white felt. It also passed along the petiole, and branched and spread out along the main ribs on the lower surface of the leaf. Further development on the leaf was not observed. It killed the leaves fairly quickly. The strands were composed of closely-woven, but for the most part parallel, hyphae, the hyphae being narrow and septate. At first the hyphae were white and delicate, but as they became older, they became darker and their walls thickened, especially in the outer hyphae. On old branches, the hyphae did not penetrate into living tissue, but young green twigs, leaves, and buds were penetrated and killed.

Thread Blight of Cacao in the West Indies was again recorded by South in an addition to an article by Bancroft (1910). South suggested, from a comparison of the mycelia from different hosts, that in all probability the Thread Blights of the West Indies were due to different fungi in different localities, and he stated that clamp-connections had been found in some of the fungi on cacao.

In 1909, Stevens and Hall gave an account of a *Hypochnus* found on fruit trees in North America. This fungus formed strands which were at first white, but subsequently became glistening brown. The hyphae were more or less parallel, very uniform in diameter (5-8 μ), septate at intervals of 40 to 120 μ. Clamp-connections were not observed. On the thread, there occurred roundish or oblong sclerotia, usually 3-4 mm. diameter, white at first, becoming rich chestnut brown, composed of compactly-woven masses of swollen, irregular hyphae. Basidia were

found in the film on the leaves, and the fungus was identified as *Hypochnus ochroleucus* (Noack).

Burt subsequently transferred *Hypochnus ochroleucus* to *Corticium* and, the name *ochroleucum* being antedated in *Corticium*, renamed it *Corticium Stevensii*. It is of interest in connection with this account of the Thread Blights, in that Burt recorded as this species a specimen on *Codiaeum variegatum* sent by Rorer from Trinidad.

Bernard, in 1907, described a Thread Blight which was found on tea in Java. The threads occurred only on the younger branches and leaves, and were white, or pale rose. On the branches they were 0.5-2 mm. in diameter, sometimes spreading out into patches; on the leaf, they branched, forming at first a network somewhat resembling a cobweb, but ultimately covering the lower surface with a thin, pale rose film. The hyphae were 4-6 μ diameter, septate, branching dichotomously; Bernard figures them as equal, thin-walled, somewhat closely septate. Bernard was unable to find anything resembling Zimmermann's "anker" cells, but on the film on the leaf he found basidia in small groups. Consequently he described the fungus as a *Hypochnus*, *Hypochnus Theae*.

In 1910, Massee recorded a Thread Blight from the Gold Coast as *Marasmius scandens*. It occurred on Cacao. The pilei arose laterally from the thread, and were about 1 mm. diameter, sessile, white, striate above, with three to five gills. There is no type specimen of this species in Herb. Kew.

Bancroft, in 1911, recorded the occurrence of a Thread Blight on *Hevea brasiliensis*, *Cinnamomum Camphora*, and *Psidium Guyava* in the Federated Malay States. On the trees attacked, the young leaves withered and sometimes became matted in dense masses, while the younger twigs were killed. Bancroft described the thread as becoming thicker on the younger branches, and spreading out on the surface of the leaf until the whole of the under surface was covered with a white mass of fine fibrils. The description suggests a species similar to the parasitic Indian Thread Blight, but Bancroft did not describe any peculiarities in the thread. He stated that the hyphae were 4-5 μ diameter, septate at long intervals and sparingly branched; the branches arose at right angles to the parent hyphae, and then bent round parallel to them: clamp-connections occurred frequently in the mycelium on the leaves, but less often in the thread on the branch.

In 1914, Richards forwarded to Kew from Malaya, a specimen of Thread Blight on *Hevea*, which was described as *Cyphella Heveae* by Massee. There is, however, some element of doubt attached to this, as the type specimen of *Cyphella Heveae*, like that of *Stilbum nanum*,

does not bear any Thread Blight, and the fungus appears to be growing on palm tissue, not on *Hevea*.

In 1918, Butler published a full description of the Indian parasitic Thread Blight on tea, and so made it possible, for the first time, to differentiate between that species and other Thread Blights, and correlate it with the species described by Zimmermann in Java.

In the majority of cases, no fructification of the Thread Blight has been found, and hence it is impossible to classify them, or identify the species of one country with those of another. From the rare occurrence of clamp-connections on the hyphae, it is assumed that they belong so the *Basidiomycetae*, and that has proved to be correct in those cases in which the fructification has been discovered.

It appears, however, possible to separate the Corticiums by the shape of the hyphae, while the remainder may be divided into two main classes, characterised by the presence or absence of anker cells.

The following account deals with these Thread Blights chiefly from a morphological point of view, and indicates certain peculiarities of the cords which may assist in correlating the species of different countries. Field notes on the effects of the fungus on the plant have been included when possible, but it has not yet been practicable to undertake the full investigation of the action of the fungi on their several hosts.

A.—Corticium Thread Blights.

1. *Corticium* sp. on *Rubiaceae*, Sumatra.

(? *Hypochnus Gardeniae* Zimm.)

Dr. C. Bernard has kindly furnished me with specimens of a *Corticium*, on a Rubiaceous plant, from Sumatra, which has a superficial mycelium with the general appearance of a Thread Blight (Plate 1, fig. 2).

The thread is 0.3-0. 5 mm. broad, white, slightly elevated in the dried specimens, but stouter and rounded in specimens preserved in formalin. It shrinks considerably and becomes flatter and thinner on drying. It is sparingly branched on the stem and runs somewhat flexuosely from node to node, but at the nodes it expands into a small sheet, or, more generally, forms a network encircling the node. Thus the length of the definite cord depends upon the distance between the nodes, and in the specimen photographed it is shorter than on stems on which the nodes are farther apart. The cord is not tough. It is bordered by a wide, thin membrane, 0.7 mm. broad.

The thread passes along the leaf stalk, and divides into very delicate strands, radiating fan-wise on the under side of the leaf from the base, and united by a thin sheet of hyphae which covers the whole under surface. In some cases the leaf is soon attacked. In other cases the leaf does not appear to be injured, and on such leaves the covering of hyphae appears powdery, owing to the presence of large numbers of basidia. It appears to be a general rule in these repent Corticiums in the East, whether Thread Blights or not, that the leaves which bear basidia abundantly are not injured by the fungus. Some basidia may be found on severely attacked and rotten leaves, but the patches which are densely covered with basidia occur, in general, on leaves which do not show signs of injury.

The lateral membrane contains a wide-meshed network of regular hyphae running parallel to the thread, or obliquely from it, sometimes with broad strands of thin-walled hyphae side by side, all united by a thin, hyaline, amorphous film. These hyphae (Plate IX, Fig. 1.) are regular, 6-10μ diameter, septate, with rare clamp connections. Some of them are quite normal, others have a strongly thickened wall. The walls of a hypha 6 μ diameter may be thickened until the lumen is only 1μ diameter. The septa, however, remain distinct and unthickened in these hyphae. Completely solid hyphae have not been observed in this species.

In addition to the larger hyphae, the lateral membrane contains fine hyphae, 0.5μ diameter, which bear hyaline globules, 1-1.5μ diameter.

The hyphae in the interior of the thread are 3-5μ diameter, regular, usually straight, thick-walled, but with the lumen and septa still evident. A few irregular bends occur, but they are rare in comparison with the usual Thread Blights. Sometimes adjacent hyphae anastomose. Anker cells and irregular inflations are absent.

The contents of the hyphae stain with eosin, but the walls and the hyaline film and globules do not. With cotton blue, the contents of the hyphae stain deeply, and the walls slightly.

The covering on the leaf contains a wide-meshed network of thin-walled, regular, septate hyphae up to 8μ diameter, united by a hyaline, amorphous film, and fine hyphae, 1 μ diameter, which bear hyaline, spore-like, globules laterally. From the regular hyphae there arise erect septate hyphae, 3 μ diameter, simple, often in groups, or branched, up to 50 μ high. The terminal cells of these hyphae are clavate, and are probably basidia, but no spores or sterigmata have been observed.

Large numbers of intrusive spores adhere to the thread.

As a Thread Blight, this differs from the more usual species in its regular, septate hyphae, and in the presence of thin septa after the

lateral walls of the hyphae have become thickened. It is probably identical with *Corticium* (*Hypochnus*) *Gardeniae* Zimm., found on *Gardenia florida* at Buitenzorg, the figure of which (Centralb. f. Bakt., Abt. 2, VII, p. 102) shows basidia in pairs at the apices of short, septate hyphae.

2. *Corticium Theae* Bernard.

I am indebted to Dr. Bernard for a specimen of this species on tea from Buitenzorg, Java.

The mycelium (Plate I, fig. 3) takes the form of a stout, rounded, continuous thread, running longitudinally along the stem, rarely branching and anastomosing. In the available specimens, it is about 0.3 mm., sometimes 0.4 mm. broad, tomentose, often with a broad membranous margin, and sometimes forming diffuse patches at the side of the cord. Bernard states that the cord may attain a breadth of 2 mm., and that the colour of the fresh specimens is pink.

The thread passes to a leaf along the under side of the petiole, and may divide into a number of strands radiating over the lower surface of the leaf, so fine that they are scarcely visible, or may form broad flat strands at the base of the leaf which divide up into finer strands after a distance of about a centimetre. Some of the leaves bear powdery patches ; these, in general, do not bear any visible thread, except perhaps at the base of the leaf. According to Bernard, the patches on the leaf are a deeper pink than the cord on the stem when fresh.

The cord on the stem and the leaves is vegetative only. It is composed of regular hyphae, 3-6 μ diameter, of the same character as those of the *Corticium* on *Rubiaceae* already described (Plate IX, fig. 1). Knee bends occur sparingly, and some of the thin-walled hyphae bear short stumpy projecting branches, just below a septum, which are probably the traces of lateral branches.

The powdery patches on the leaves bear basidia on a foundation of interwoven hyphae which are similar to those of the cord. The basidia (*fide* Bernard) are ovoid, 20-25 x 6-8 μ, with four sterigmata 6-8 μ long, and ellipsoid spores, 7-9 x 5-7 μ.

This species is a true Thread Blight. Its cord is stouter than that of the species on *Rubiaceae*, and it apparently differs from the latter in the shape of its basidia.

In his first account of this species, Bernard instituted comparisons with Massee's *Stilbum nanum* and Zimmermann's " Spinnenwebeziekte", from the descriptions, and came to the conclusion that his species differed from these. In another publication in the same year he stated that Massee's Thread Blight was evidently the same as *Corticium Theae*,

basing his conclusion on the photograph of Thread Blight, published by Watt and Mann in The Pests and Blights of the Tea Plant, 2nd Ed., Plate XX, fig. 3. The resemblance, however, is merely superficial.

Species of *Corticium* with aerial mycelium occur in Ceylon on tea, *Erythroxylon Coca*, and *Oxyanthus tubiflorus*. These have been referred to *Corticium Theae*, but a glance at the Java specimen shows that the reference is incorrect. The Ceylon species do not form a visible thread. They form a delicate film of hyphae along the stem and over the leaves, quickly rotting the latter and binding them to one another and to the stem. The effect is similar to that of *Corticium Koleroga* in India, and, like the latter, the disease caused by them is known as Black Rot. Sometimes a very fine brown fibrillose strand can be detected under a low magnification, but there is no clearly visible thread as in the Thread Blights. The hyphae, too, are not thick-walled or solid.

The basidia of these latter species are usually borne on powdery white patches on leaves which do not exhibit signs of injury. On coca, however, the mycelium on the stem may bear basidia, and the fungus is then evident to the naked eye as a broad white streak along the stem, sometimes extending over two-thirds of the circumference. But even in that case, the visible white area is too broad and diffuse to be regarded as a thread. The Ceylon species of *Corticium* which have aerial mycelium are not, as far as is known, Thread Blights.

3. *Corticium* sp. on Tea, Sumatra.

Dr. C. Bernard has also sent me another Thread Blight on tea from Sumatra, which is probably a *Corticium* (Plate I, fig. 1).

The thread is white, about 0.2 mm broad, generally flat and not very conspicuous, expanding here and there into a thin sheet, or dividing up into hyphae and disappearing macroscopically. The hyphae of the thread are regular, 4-8 μ diameter, thick-walled, septate, with some solid hyphae in the older parts of the thread. Clamp connections have not been observed. With eosin or cotton blue, the contents of the hypha stain, but the wall does not.

At intervals along the thread there occur irregularly pulvinate, yellowish-white cushions, up to 6 mm. diameter. These may be situated at irregular intervals, or confluent in masses up to 2.5 cm. long ; they may occur at the old leaf scars, or at a fork ; but they are not confined to those positions, and the majority in the available specimens have no relation to any definite structural feature of the stem. These cushions are not sclerotioid, but soft and spongy, with a glabrous, wrinkled, outer coat of interwoven hyphae. The hyphae in the interior are loosely inter-

woven, regular, 3-5 μ diameter, with distinct septa, of the same character and the same reactions to stains as those of the thread.

The thread passes from the stem *via* the petiole to the lower surface of a leaf, and breaks up into hyphae which either cover the leaf with a thin film and kill it, or else give rise to basidia in white patches. The leaves which bear basidia do not exhibit signs of injury. The white patches are usually broken up, not continuous, but it is possible that they may ultimately coalesce. Similar patches are formed on the stem. Mature basidia have not been found. The structures which are taken to be immature basidia occur on short, erect, septate hyphae, both laterally and terminally, and are narrow-oval or clavate, 9 x 4 μ.

This species apparently differs from *Corticium Stevensii* in that the thread is white, not brown, and the cushions are not sclerotia composed of compact irregular hyphae, but merely spongy masses of regular hyphae.

In De Thee, vol. IV, p. 86 (1923), R. Menzel has recorded the occurrence of the larvae of a Cecidomyid in these cushions. This raises the question whether the cushions are a normal part of the fungus or galls caused by the insect.

B.—Marasmioid Thread Blights With Anker Cells

(1) The Indian Tea Thread Blight.

Specimens of this Thread Blight have been kindly furnished by Mr. A. C. Tunstall, the Mycologist of the Indian Tea Association, and I have others collected below Darjeeling in 1900.

The cords on the stem are white, flattened or rounded, up to 0.5 mm. broad, often expanding into broader patches at the persistent bases of dead leaves. In some specimens the cords are tomentose, or slightly woolly, on the exterior, though firm and compact within. Butler describes the cords as firm and smooth on the surface, but becoming fluffy and of a consistency resembling cotton wool. It would appear that, as in other species, the character of the surface of the cord varies with its age, or with weather conditions. The cords on the stem often branch and re-unite, forming a network. On the thinner twigs, the cords tend to become stouter, a feature which appears to be peculiar to this class of Thread Blight. When old, the cord acquires a brownish tint.

From the stem the cord passes to the under side of the leaf along the petiole. At the base of the leaf blade it usually divides into a large number of finer cords which spread out fanwise over the leaf surface. These cords are united laterally by a network of hyphae, so that the under surface of the leaf is covered with a thin, white sheet. In some

instances, the only cord evident macroscopically, runs along the mid-rib, the remainder of the leaf surface appearing covered with a white sheet only, but in such cases, a microscopic examination usually reveals narrow, white cords, about 0.2 mm. diameter, radiating from the base of the leaf. The sheet of fungus tissue on the leaf is minutely tomentose, or may appear silvery when very thin. Where leaves or twigs are in contact, the mycelium passes from one to the other and binds them together. Butler records that, in great humidity, it may cross spaces up to half an inch.

A longitudinal section of the cord on the stem shows that it is composed, for the greater part, of hyphae which run parallel to the stem, but more or less flexuosely. The outer edge usually bears a few free spreading hyphae.

The main hyphae of the cord (Plate IX, fig. 2) are about 3 μ diameter, straight, or here and there closely flexuose. They are either thick-walled or solid, with all possible transitions between the two. In many cases, the lumen is reduced to a narrow cavity which is discontinuous, or the lumen may only be present for a short length where the hypha is swollen to a greater diameter. Swellings and abrupt bends, however, are rarer in the available specimens of this species than in other Thread Blights. Branches arise at an acute angle from the parent hyphae, and usually soon take a position parallel to the latter, though in a few instances they run diagonally across the thread. Sometimes the branch is thick-walled and the parent hypha solid. The branch arises just below a septum, but this is not evident where the parent hypha has become solid. When the thread is teased out, lateral angular swellings may be found on some hyphae, which represent the points of attachment of branches. Branching, however, does not appear to be common in these hyphae. Similarly, long lengths of thick-walled hyphae, up to a millimetre long, may be traced, which show no signs of septa. Clamp connections have not been observed in these thick-walled hyphae. It would appear that the septa are absorbed, and that the clamp connections are represented by swellings on the thickened walls. Short, irregular, jointed lengths sometimes occur in the solid hyphae.

At the base of the cord, the hyphae are parallel and thin-walled, with evident septa. The basal layer consists of a continuous sheet of thin-walled hyphae, fused together laterally, while in the middle of the cord the same hyphae occur to a height of about 30 μ. These thin-walled hyphae may attain a diameter of 7 μ, varying from 3 μ to 7 μ. The tissue formed by them appears looser and whiter than the remainder of the cord.

At the exterior of the cord, many of the hyphae are 1.5-2 μ diameter, thin-walled, and septate, with clamp connections. These arise as lateral

branches from the thick-walled hyphae, and their mode of branching is the same as that of the latter. Many of these thin-walled hyphae, however, bear short lateral outgrowths up to 6 μ long, equal, or slightly inflated at the tips, or sometimes conoid, perpendicular to the parent hyphae (Plate IX, fig. 4.). These out-growths are usually simple, sometimes forked, and may be scattered, or arise close together in clusters ; they are generally rough with minute, hyaline, refringent granules, as are also the hyphae from which they arise.

Some of the thin-walled hyphae at the exterior of the thread terminate in the peculiar cells which were named " anker " cells (Plate IX, fig. 3.) by Zimmermann. These, however, are rare on the cord on the stem in the available specimens of this Indian species, but are common in the film on the leaf. On the stem, they may be thin-walled, or have only slightly thickened walls, and spherical, 8-16 μ in diameter, without any apical or lateral projections. Generally they are spherical or oval, with solid apical and basal processes, and measure 12-24 x 8-10 μ. A few have a single lateral process, while others have two processes towards the apex. In the film on the leaf, the same shapes occur, together with larger, fusoid cells, up to 50 μ long and 12 μ broad, with long, solid, obtuse apical and basal processes and one or two lateral processes. Three processes, in addition to the apical and basal processes, have been observed, but these have been irregularly situated, not in a median circle. In general, the anker cells on the leaf are more strongly thickened than those on the stem.

It is probable that the spores referred to by Berkeley in his account of *Corticium repens* were the anker cells.

In addition to the forms of hyphae already described, very slender hyphae, 0.5-1 μ diameter, run among the outer hyphae of the cord. These may be free for short distances, but are frequently closely adherent to the thick-walled hyphae and over-run them irregularly. They are usually irregularly and closely wavy, and bear short lateral branches of a similar character (Plate IX, fig. 5.). They are often encrusted, or beaded, with minute, hyaline, globose granules. These fine hyphae occur in greatest number at the sides of the cord, spreading out over the bark ; and in some cases they are united into hyaline, membranous patches.

A few of the hyphae, both thin-walled and solid, bear free, clavate, or nodular, processes, about 12 μ long and 2 μ diameter, studded with minute, sessile granules, or bristling with minute points which sometimes bear granules (Plate IX, fig. 6.)

All the hyphae at the exterior of the thread tend to be more or less encrusted with hyaline granules, but these are especially numerous on the hyphae which bear the short lateral outgrowths and on the very slender

hyphae. The greater number of them are situated laterally on the hypha, but in many instances they are terminal on the short branches and then resemble spores. Their nature has not been ascertained ; on staining with eosin, they appear to take the stain, but the colour washes out immediately with water ; they dissolve in concentrated hydrochloric acid without effervescence, and appear to diminish in size when the hyphae are mounted in glycerine. It seems probable that they consist of some substance which serves to bind together the outer hyphae of the cord, and to fasten it to the host plant.

With cotton blue, the thick-walled hyphae stain, but the solid hyphae are hardly coloured. With eosin, the walls of the hyphae do not stain, but the cell contents do; consequently the solid hyphae remain colourless, while those with thickened walls show thin, coloured, central lines, often interrupted where the hypha has become completely solid. With methyl violet after tannic acid, all the elements stain deeply.

In the film on the leaf, the hyphae in the cords are thin-walled, septate, and about 2 μ diameter in the available specimens. From a comparison with other species it is probable that some of these may become thick-walled later. Between the cords, the film is a network of thin-walled hyphae, 2 μ diameter, with numerous, short side branches, mingled with the fine branched hyphae, 0. 5-1 μ diameter, which are encrusted with hyaline globules. Anker cells are abundant.

The effect of this Thread Blight on tea is described by Butler as follows :—

" The effect ón the leaves is that browning and death of the leaf cells sets in, some time after the film spreads out on the under surface. This effect, is, for a time, sharply limited to the part covered by the fungus, but, especially when the attack begins from the base, the rest of the leaf soon withers and it falls off.....No trace of penetration of the epidermis has been detected, and the fungus can be lifted off when wet without breaking it. It seems probable that the peculiarly branched inner layer.....forms a sort of hold-fast or appressorial layer, though the cuticle does not seem to be indented or marked by its branches. On the petiole and green part of the stem, the strands are composed of hyphae similar to those of the outer layer on the leaf.....and entirely superficial. Lower down, however, the fungus enters the tissue of the stem....Branches pass down through the cork layer, which....is not continuous when first formed, and accumulate in the cortex below the young cork. The result is the gradual destruction of all the tissues external to the hyphae....The hyphae have been traced as far in as the cambium".

(2) The Cobweb fungus of Java.

The following details are taken from Zimmermann's account of this fungus.

The mycelium occurs on the branches as a thick, pure white cord, which can easily be seen with the naked eye. From the branches, the cord travels to the under side of the leaves, and spreads out gradually in very fine threads over the whole surface. The film formed by these fine threads may be likened to a cobweb.

The leaves attacked soon lose their green colour, gradually become more or less dark brown, and die. If affected leaves come in contact with sound leaves, the fungus can pass over to the latter, and in that way, and by the growth of the cord along the branch, a large number of leaves can be killed. In consequence, branches of considerable thickness may die.

The cobweb fungus occurs on coffee throughout Java, but it is not common. It appears to occur in localities which are exceptionally damp, or where the shade is dense because of the thick growth of the coffee.

The cords on the stem, and the films on the leaves, consist of very fine hyaline hyphae, which run parallel to one another in the former, but on the leaves are united in an irregular network. In preparations of the film of the leaf, it is seen that the hyphae are not all of the same kind. Some are cylindric, and straight for great distances, while others are more or less flexuose, and bear very numerous, short, side branches. These short side branches are especially numerous on hyphae which are not in contact with the leaf, but project freely into the air (Plate IX, fig. 7, after Zimmermann).

In addition, there occur on the leaf and the stem, between the hyphae, and united to them, peculiar bodies, which, when they are fully developed, are furnished with several processes of a homogeneous nature and a central cavity with granular contents (Plate IX, fig. 8, after Zimmermann). Two of the processes are especially long, the basal one, which is united to a hypha, and the apical one, which ends in an obtuse tip. Besides these two, there are generally three other smaller processes situated mid-way between the other two. These bodies may be termed anker cells, because of their shape. On following the development of the anker cells, it is seen that they originate as an elongated cell, inflated in the middle, which produces the median projecting processes later.

A specimen of a Thread Blight with anker cells (Plate IV, fig. 1) has been forwarded to me by Dr. C. Bernard from Sumatra where it

occurred on tea. It is on a rather thick stem, with one lateral twig, and is a comparatively young development. The cord branches and forms a network on the main stem, and runs up the lateral twig, but it does not become thicker on the latter, probably because of its age. It spreads out on the underside of the leaves and forms a continuous film.

The hyphae of the thread are similar to those in the corresponding Indian and Ceylon forms. Septate hyphae were not found at the base of the thread, and the "toothed" hyphae figured by Zimmermann are rare. Many of the anker cells are thin-walled, again probably owing to immaturity ; some are fusoid or ovoid, 16-32 x 10-6 μ, as shown by Zimmermann, but the majority are globose, about 12 μ diameter, as in the Indian and Ceylon collections. Some of the globose anker cells lack a terminal point, and lateral points are rare.

The specimen appears to be identical with the corresponding Indian and Ceylon forms.

(3) Form on *Gymnosporia emarginata* and *Strobilanthes* sp., Ceylon.

A Thread Blight of the same type as the Indian parasitic species on tea occurs on a bush of *Gymnosporia emarginata* in the Botanic Garden, Henaratgoda, Ceylon, where it has been under observation for some years.

Gymnosporia emarginata Hk. f. (*Celastraceae*) is properly an inhabitant of the dry zone of Ceylon, and has pronounced xerophytic characters. It is a scrambling shrub, with long, rigid branches which bear short horizontal spinous twigs. The plant at Henaratgoda is growing in the open, and forms a loose mass, about eight feet high, of long decurving stems. The leaves and flowers are borne in clusters, at distances of one half to one inch, on short lateral shoots not exceeding one-eight of an inch in height, scattered along the stems, or at the base of the spinous twigs, or on the twigs. Usually there are two leaves in each cluster.

The Thread Blight (Plate III) runs along the branches, generally on the under surface. It is white, somewhat flattened, minutely tomentose, up to a millimetre wide, sometimes with a broad membranous border, sometimes expanding into a sheet, which, in rare cases, almost surrounds the stem. The cord is usually thicker on the smaller branches. It is seldom branched, but occasionally it divides and the branches re-unite and form a network. It often follows a somewhat zigzag course from the base of one lateral shoot to the next. When the cord meets a lateral shoot it forms a dense weft, or cushion, of mycelium round its base, and sends out a branch which travels up the leaf stalk and spreads out in a thin film on the under surface of the leaf. Sometimes fine cords

can be detected in this film, radiating from the base of the leaf : in other cases the film is uniformly thin. When old, the cord on the stem becomes brownish.

As a result of the attack of this fungus, one finds long lengths of the branches on which all the leaves are dead and brown. Beyond these, however, on the parts which have not yet been reached by the fungus, the leaves are green and healthy. The leaves remain for some time hanging from the branch, fastened to it by the mycelium. The thick branches do not appear to be damaged by the fungus, but when it grows over small branches these latter are killed. The part of the lower side of the leaf which is covered by the film becomes greyish or blackish, while the corresponding upper surface becomes yellowish green, mottled with brown, with a watery green margin. In this stage,the whole of the film can readily be detached from the leaf when fresh. The change in the colour of the leaf appears to be late in developing, perhaps because or the coriaceous nature of the leaf in this species. Finally, the whole leaf dies and turns brown.

The change in the colour of the leaf is best seen in wet weather. In dry weather, a leaf may be almost completely covered by the fungus without exhibiting any sign of injury.

In addition to the foregoing mode, the leaves may be killed by the attack of the fungus on the leaf stalk, or on the short shoot, without the occurrence of any film on the leaf blade. The short shoot, as already stated, is covered by a weft or cushion of mycelium, and this mycelium attacks the leaf stalk, etc. The leaf stalk turns brown first, and this is quickly followed by the browning of the whole blade. The two leaves of a shoot do not, as a rule, die at the same time.

The thread is very compact, and yellowish internally. Its main hyphae are 3-4 μ in diameter, thick-walled or solid, and do not differ from those of the parasitic Indian tea Thread Blight. Hyphae 2 μ in diameter, with thin walls, occur on the exterior of the thread and in the membranous film which spreads from its base over the branch. Toothed hyphae, i.e. hyphae with short lateral branches, such as occur in the corresponding Indian form, are rare. The ultimate fine branches, 1-0.5 μ diameter, are usually long and straight, but sometimes bear a whorl of branches arising from a common point. These fine hyphae arise from the thick-walled hyphae, and are occasionally grouped in tufts. Club-shaped processes, either simple or lobed, up to 12 μ high and 3 μ diameter, are also present. The fine hyphae, and the thick-walled hyphae towards the exterior of the thread, are beaded with hyaline granules, and there is a well-developed amorphous layer on the exterior of the thread. In addition, the thread, and the film on the leaf

are in this form strongly encrusted with amorphous masses of calcium oxalate.

Anker cells (Plate IX, fig. 9) are present in large numbers on the exterior of the thread, but become rarer within it. In general they are spherical, more rarely oval, with an apical and a basal projection only. Spherical anker cells which lack an apical point are not uncommon. The majority are small, do not exceed a total length of 12-16 μ, and are comparatively thin-walled. Spherical anker cells, however, may be found up to 24 μ in diameter, and elongated fusoid cells up to 35 x 7 μ. In rare cases a single lateral point is present.

At the base of the thread, the tissue is whiter and appears looser than that above it. This basal layer forms a continuous white sheet or is split into anastomosing bands. The hyphae of which it is composed are more regularly longitudinal and parallel than those in the main body of the thread, and are united by an amorphous film in which numerous granules are embedded. These hyphae are thin-walled and up to 10 μ in diameter. Septa are present, but clamp connections have not been observed. Many of the septa are perforated, and wholly or partly absorbed (Plate IX, fig. 10). Lateral branches of a hypha 10 μ diameter may be only 3 μ diameter.

A recently-developed film on the leaf, in places where no cord is evident, is based on a foundation of thin-walled hyphae up to 7 μ diameter which form a wide-meshed network over the surface. These are united by a continuous amorphous film in which are embedded fine beaded hyphae, 1-0.5 μ diameter, and a few solid hyphae, 2 μ diameter, studded with granules. Anker cells are rare in the youngest stages, but become abundant later. They are hyaline, with granular contents, at first, but subsequently become brown and homogeneous. The structure of the thread on the leaf is the same as on the stem.

The tissues of the dead leaf are permeated by hyphae which vary from 1 to 4 μ in diameter. The larger hyphae pass through the stomata, but the finer, 1 μ, hyphae appear to penetrate the epidermis at any point. It has not, however, been determined at what stage of the attack penetration takes place.

On the older stems, the finer hyphae penetrate through the cortex into the wood, but there is no external evidence of injury. On the younger stems the tissues are browned and the stem ultimately killed; as far as has been determined, it appears that in such cases only the finer hyphae are present in the tissues in the earlier stages

Another collection, apparently of the same species as that on *Gymnosporia*, was made in one of the wettest districts in Ceylon, where it was found growing on a species of *Strobilanthes*

The cord on *Strobilanthes* branches freely on the thicker parts of the stem, the branches anastomosing and forming a network; the marginal film frequently spreads out into a broad patch which may completely cover the area enclosed in the meshes of the network. The cord is white and minutely tomentose, but when rubbed the surface appears brown, and the brown discolouration extends to a small depth within the cord. The discolouration is due to the presence of brown amorphous masses, anker cells, and algae which have been included in the outer layers. The same colour is evident on a worn specimen of the parasitic Indian tea Thread Blight, and on the older parts of the thread on *Gymnosporia*; it is more marked in this specimen on *Strobilanthes*, but the latter appears to be an old specimen. The threads of the cord, even those on the exterior, are nearly all almost solid, and the finer hyphae are difficult to find. The amount of debris attached to the exterior of the cord may also be taken as evidence of age.

Any spores which happen to fall on the cord of a Thread Blight are liable to become attached. On tea, *Pestalozzia* spores are frequently found adhering to the thread. In the form on *Strobilanthes*, there is a large number of spherical, echinulate, greenish-hyaline spores, 3-4 μ diameter, resembling the spores of a *Sterigmatocystis*, which appear to be intrusive.

The cord passes along the leaf stalk and spreads out in a thin film on the lower side of the leaf. In one instance, a leaf 16 cm. long and 9 cm. broad was completely covered, except for the apical 2 cm., by a thin, white film which to the naked eye appeared uniform, but which when examined under a lense showed fine underlying threads, radiating fanwise from the leaf stalk. Other leaves show similar patches of less extent, but all advancing uniformly over the leaf from the leaf stalk.

In another instance, the mycelium had spread from a dead stem to a leaf, attacking the latter at the margin about the middle of its length. The mycelium bound the edge of the leaf to the stem, and then spread out over the lower surface fanwise in repeatedly-dividing strands which extend over an area 8 cm. long and 12 cm. broad. From these strands, the continuous covering was just beginning to develop at the time of collection, and it can be detected as a glistening film when the dried specimen is viewed obliquely.

Attention was drawn to this plant of *Strobilanthes* by its blackened leaves. The upper surface of a leaf had turned black over an area which corresponded exactly with the extent of the fungus film on the under surface. In general, the blackened patch was continuous, but in the case of the leaf noted in the foregoing paragraph, a system of branching black lines radiated from the point of attachment, in correspondence with the

strands on the lower surface. The effect of the fungus on the thin leaf of the *Strobilanthes* was greater, and apparently more immediate, than on the xerophytic *Gymnosporia* leaf.

The structure of the thread in this form is identical with that of the thread on *Gymnosporia*. The anker cells are the same shape and size, toothed hyphae are rare, and the fine ultimate hyphae, though scanty on the old thread, are also the same.

Judging from Zimmermann's figures, the anker cells of the Java form differ from those of the other two. In the Ceylon and Indian forms, the anker cells are most frequently spherical or ovoid, especially in the cord on the stem. It may, however, have happened that Zimmermann drew his figures only from the film on the leaf ; and, in that situation, they can be matched by anker cells on the leaf in the Indian and Ceylon forms. In a recent specimen from Sumatra, which is probably identical with Zimmermann's species, the anker cells are chiefly spherical. It would appear most probable that these Thread Blights which possess anker cells are identical. In no case is the fructification known, but the mycelium agrees in general structure with that of the Thread Blights which have been found to belong to species of *Marasmius*.

C. Marasmioid species without anker cells.

(1) *Marasmius pulcher* (B. & Br.) Petch.

This is the common Thread Blight of tea in Ceylon, where it has also been found on nutmeg, *Beloperone oblongata*, *Garcinia ferrea*, etc. It occurs on tea in India, and, as far as the specimens can be relied on, it is the species to which Massee gave the name *Stilbum nanum*.

The cord is white, minutely tomentose, becoming glabrous and slightly brownish when old. It is usually about 0.5 mm. diameter, with a narrow border closely adherent to the host plant. As a rule, it runs longitudinally along the lower side of a twig, giving off lateral branches which usually do not proceed far before terminating in a pencil of hyphae. It does not become stouter as it ascends the stem or twig, and, in general, it does not form a network on the stem (Plate IV, fig. 3).

When infection occurs on a thick tea branch in a wound where the wood is decaying, the growth of the mycelium is more vigorous, and cords may spread in all directions from the wound, branching repeatedly.

From the stem, the cord proceeds along the leaf-stalk to the lower surface of the leaf. It may form a network on the leaf-stalk. On the lower surface of the leaf it may divide into several branches radiating from the base, or it may run over the leaf as a single cord, often near

the margin. But even in cases where it has divided into numerous branches it does not, as a rule, form a continuous film on the living leaf (Plate IV, figs. 1, 2.). This has been the case in the numerous specimens examined, but it is possible that it might form a continuous film under conditions of greater humidity. The cord passes from one leaf to another, or from a stem to a leaf, if the two are in contact, but it has not been observed to bridge any gap (Plate V. fig. 4).

The main hyphae of the cord are similar to those of the Thread Blights which possess anker cells, but abrupt knee bends occur more frequently. The hyphae are for the most part 2-3 μ diameter, thick-walled or solid. Some attain a diameter of 5 μ. Septa are rare in the thick-walled hyphae, and clamp connections have not been observed. Some of the solid hyphae separate into lengths with swollen or irregularly nodular ends (Plate IX, fig. 12). The hyphae usually stain with eosin, and strongly with cotton blue.

At the base of the cord, some hyphae are thin-walled, 2-5 μ diameter, with evident septa, but these do not form such a distinct tissue as the similar hyphae in the Thread Blights which possess anker cells.

The thin film which borders the cord contains a network of thick-walled hyphae about 2 μ diameter, from which arise large numbers of very fine branches, apparently solid threads, about 0. 5 μ diameter. Some of these branches remain short and simple, but most of them give off secondary branches, singly or in whorls, and these secondary branches may repeat the process, so that a dendroid structure resembling a conidiophore is produced (Plate IX, Fig. 14). The main trunk of this dendroid structure is usually thickened in a fusoid shape at the points where its branches arise. In some instances, the primary fine hypha becomes thickened clavately above and numerous branches radiate from this clavate head. In other cases, simple fine hyphae arise in tufts directly from the thick-walled 2μ hyphae. The dendroid structures may attain a total length of 20 μ.

The same dendroid hyphae arise from the superficial hyphae of the thread. In some instances they bear hyaline globules at the ends of the branches, thereby increasing the resemblance to a conidiophore. Hyaline globules, however, appear to be less common in this species than in the Thread Blights which possess anker cells. In some specimens, they are almost absent ; in others, they occur on the thick-walled hyphae at the exterior of the thread. As in other species, the cord becomes covered with a hyaline film, and the narrow border has a basal film of the same character. This appears to be formed in this species chiefly by the fine dendroid hyphae. Toothed hyphae have not been observed in this species.

When a leaf which bears this Thread Blight dies, and remains hanging from the twig, attached by the cord, the fungus grows out as a very thin powdery film over the whole of the lower surface. This film consists of a few hyphae, 1.5-2 μ diameter, with walls thickened or not, sometimes bearing innumerable dendroid hyphae, sometimes merely spinulose. Numerous short free clavate branches are present, up to 8 μ long, and these may be either spinulose or bear short fine threads.

These powdery films produce large numbers of shallow pezizoid bodies, up to 0.5 mm. diameter, often closely crowded together and covering nearly the whole film (Plate VIII, fig. 1). They are cream-coloured or yellowish internally, with a white pruinose margin. They contain 4-spored basidia, with cymbiform, hyaline spores, 6-8 x 4 μ.

The same fructification has been found on expansions of the Thread Blight cord on thick tea stems, especially in cases where the cord arose from a wound containing decaying wood. It has also been found on stems of *Beloperone oblongata*, on expansions of the cord and on the cord itself; and it has been developed on tangles of leaves and stems bearing Thread Blight, which have been left to decay on soil under a bell glass.

This fructification was sent to Berkeley and Broome by Thwaites, and was described by them as *Cyphella pulchra* B. & Br., Fungi of Ceylon, No. 665. In the co-type in Herb. Peradeniya, the *Cyphella* cups are seated on a film of the structure described above, and one piece has part of the cord attached.

When the supposed *Cyphella* is examined under a microscope, however, it is seen that many of the cups are incised on one side, and in some cases one or more ribs radiate across the cup from the incision (Plate IV, fig. 3). This gave occasion for doubting whether the fungus was really a *Cyphella*, and on keeping a tangle of Thread Blight as described above, a sessile *Marasmius* was obtained. This has since been found on leaves of tea, covered with Thread Blight, which had fallen into the middle of a tea bush and decayed there. *Cyphella pulchra* is, therefore, an imperfect development of a *Marasmius*, which must be known as *Marasmius pulcher* (B. & Br.) Petch.

An extensive development of *Marasmius pulcher* has also been found on dead leaves and twigs in a tangle formed by Thread Blight on *Garcinia ferrea*. In this case, the thin powdery film and the expansions of the thread were not present. The pilei arose either from the thread, or from parts of the dead leaves or twigs on which no mycelium was evident externally. It is clear, therefore, that the cord gives rise to hyphae which penetrate dead material as a normal mycelium.

Marasmius pulcher, in the specimens hitherto seen, is sessile, resupinate or laterally attached, or shortly stalked, reniform or orbicular, up to 3 mm. diameter, white, convex, sulcate over the gills, minutely pruinose, lower surface and gills white or ochraceous. Gills few, one to four extending from the point of attachment to the margin, with three or four shorter ones. Spores white, cymbiform, 6-8 x 4 μ.

In Herb. Kew, there are specimens of this Thread Blight on tea from India, collected in 1900 (No. 14346), which were sent from the Calcutta Herbarium and were included by Massee in the cover of *Stilbum nanum*. One of these includes the fructification on decaying leaves, both in its apparent *Cyphella* and its fully developed *Marasmius* form.

This species has been under observation for some years on nutmeg in the Royal Botanic Gardens, Peradeniya. It does not appear to kill the twigs or the leaves, nor to cause the latter to fall prematurely.

On October 1st. 1918, all dead leaves were removed from an affected branch, and a diagram made showing the remaining leaves and the distribution of the cords. On December 16th, one leaf which bore Thread Blight became detached, but remained suspended from the twig by the cord ; it was the oldest leaf on that twig. On another twig on the same date the oldest leaf, which did not bear any Thread Blight, was turning yellow, and this fell a few days later. On December 30th, the oldest leaf on a third twig was turning yellow and fell when touched : this leaf did not bear Thread Blight.

No more leaves fell up to March 9th, 1919. The oldest leaves on two twigs were then turning yellow ; both these leaves bore Thread Blight, and after becoming detached a day or two later, remained suspended from the twigs. At this time there was a general fall of the oldest leaves from this tree. On March 27th, the oldest leaf on another twig which bore Thread Blight was turning yellow. At this date there was a general fall of the oldest leaves all over the nutmeg grove, after six weeks' drought followed by one week's rain.

When the leaves which bear this Thread Blight die, the changes in the colour of the leaf are exactly the same as on the unaffected leaves which are thrown off normally. In both cases, the yellowing of the leaf begins from the leaf stalk. Again, in all the cases noted above in which a leaf which bore Thread Blight died, it was the oldest leaf on the twig, and it died at the same period as other oldest leaves which did not bear Thread Blight. Hence it appears that this Thread Blight is not parasitic.

In general, the nutmeg or tea leaf does not show any signs of injury in the neighbourhood of the cord. When the cord runs over a stoma

on a nutmeg leaf, the depression in which the stroma is situated is filled by a plexus of mycelium, but the hyphae do not enter the stoma.

On the tea stem, the bark of which is usually irregularly longitudinally cracked, the hyphae of the cord run in the cracks, and give off fine branches, about 1μ diameter, which penetrate between and into the dead outer cells. These fine branches may be beaded with hyaline granules, and they may be dendritically branched. They have not been observed to penetrate below the tabular cork layers.

A species of Thread Blight, similar in structure to the thread of *Marasmius pulcher*, has been observed on a cacao stem from the Gold Coast. The thread runs irregularly along the stem, and is white, thin, pruinose, 0.1. mm. broad, with a thin pruinose border, up to 0.2 mm. wide, which in places expands into pruinose patches. The hyphae are hyaline, flexuose, thick-walled or solid, 2-2. 5 μ diameter. The exterior hyphae and those in the marginal film bear clavate branches, up to 12 μ high, 2 μ diameter, densely covered with radiating fine hyphae, 0.5 μ diameter and up to 10 μ long, or the same fine hyphae arise in tufts from the 2 μ hyphae. No fructification occurred with this thread,

It may be noted that the mycelium of *Hirneola polytricha* often spreads over the thicker stems of the tea bush in white, branching strands which resemble a Thread Blight. These are distinguished from the Thread Blights by the form of the hyphae.

(2) *Marasmius scandens* Massee.

A white Thread Blight which occurs on cacao, kola, etc., in West Africa was described by Massee under the name *Marasmius scandens* from specimens sent by Mr. W. S. D. Tudhope from the Gold Coast. Subsequently Mr. Tudhope kindly forwarded sterile specimens of what is believed to be the same Thread Blight on cacao, and I am indebted to Mr. R. H. Bunting for an extensive collection of both fertile and sterile specimens on cacao and kola. Massee did not describe the structure of the thread, and there is no type specimen in the Kew Herbarium.

In one specimen, on a cacao branch, 2-3 cm. in diameter, (Plate VI, fig. 1.) the white cords are stout, up to 1 mm. broad and 0.4 mm. thick, compact, prominent, rounded above, and, in general, lacking a membranous margin. They branch freely, and the branches anastomose to form a network. In one place, several main cords run more or less parallel to one another, united by numerous branches. On thinner stems, the cords are not so stout, and are frequently furnished with a membranous border, but there is the same tendency to form numerous cords on one stem. The thread is at first tomentose, becoming glabrous

and brown when old. But the old brown cords are white internally.

The thread travels to the leaf *via* the leaf stalk, and is usually confined to the under surface. Towards the base of the leaf, the thread is about 0. 3 mm. broad, diminishing as it travels towards the apex and divides into numerous branches which finally terminate in pencils of hyphae. Sometimes it forms more or less circular, felted patches of hyphae, up to 5 mm. diameter, near the base of the leaf, and similar patches occur where two leaves are united by the mycelium. On one leaf, thin powdery patches, covering an area 2-3 cm. long and broad, and superficially resembling the fruiting patches of a *Corticium*, were observed.

The hyphae of the thread are 2-3 μ in diameter, thick-walled or solid, flexuose, of the usual Thread Blight type. They stain with eosin. In the specimen on the thick cacao branch, oval hollow inflations are frequent on the solid hyphae, and some hyphae, 2 μ diameter, exhibit lengths up to 100 μ long over which they are irregularly swollen to a diameter of 4 μ (Plate IX, fig. 15), but neither of these appears to be of general occurrence. The outer hyphae may bear numerous very fine, solid, tapering hyphae, 0. 5 μ diameter and up to 60 μ long, simple or branched.

Septate, thin-walled hyphae, up to 5 μ diameter, occur sparingly in the interior of the cord towards the base, and rather commonly in the basal layer. Clamp connections are present on these hyphae. Branched hyphae, with perfect lateral branches, are also found towards the base of the cord.

The hyphae at the exterior of the thread are verrucose with minute hyaline globules, and the same globules occur on the very fine tapering hyphae. Here and there the thread is overlaid by a hyaline amorphous film which does not stain with eosin, and in an old thread the outer hyphae are encrusted with brown amorphous masses.

The thin border, when present, contains a network of thick-walled hyphae like those in the cord, together with fine stainable, apparently normal hyphae, about 0. 5 μ diameter, and fine, tapering, solid hyphae which do not stain with eosin. All these are embedded in a hyaline amorphous film.

In the powdery patches on the leaf, mentioned above, the hyphae of the thread spread out fanwise and are interwoven into a sheet by a network of branches. Most of the hyphae in the patch are thin-walled, 2-4 μ diameter, and exhibit septa and clamp connections. They are united by a hyaline amorphous film, in which fine, tapering, solid hyphae occur. The powdery appearance of these patches is due to incrustations of calcium oxalate.

At the tip of a cord, where it divides into a pencil of hyphae, a hyaline film, containing numerous globules and a few simple, fine, solid hyphae, underlies the thread. A small piece taken from the apex of the cord in one specimen showed a remarkable assortment of foreign bodies attached to the mycelium. These included a cymbiform, dark-brown ascospore, probably of a *Hypoxylon*, 9 x 4 μ ; another spore of the same type, 23 x 9 μ ; a septate, fusoid, brown ascospore, 14 x 7 μ ; *Diplodia* spores ; a greenish, spherical, spinulose spore, 3-4 μ diameter, in abundance, probably an *Aspergillus* ; alga cells in groups of four ; etc. The occurrence of foreign fungus spores and alga cells strengthens the supposition that the hyaline amorphous film is at some stage in its formation strongly adhesive.

As a rule, the sporophore is attached to the cord (Plate VIII, fig 2), though on old decaying leaves it may arise at a point where no cord is evident macroscopically. It springs from the top or the side of the cord, and has a short stalk, usually curved, up to 0. 5 mm. high, 0. 2 mm. diameter, lateral, longitudinally fibrillose, blackening from the base upwards. The pileus is convex, reniform or orbicular, up to 8 mm. diameter, thin, minutely pruinose, sulcate over the gills, or even. The epidermal cells of the pileus are crested with short blunt spines. The gills in the largest available examples are distant, up to six in number, adnate, ventricose, sometimes forked and with the interstices reticulated.

In the majority of the available specimens, the pilei are poorly developed, and up to 3 mm. diameter, plane, or crisped at the margin, or with a reflexed margin. Some of these have two or three fold-like gills, others have a few folds radiating from the stalk and terminating half way across the pileus, while others do not show any trace of gills.

In the dry specimens, the pileus is flexible, brownish fawn above, cream-coloured below. Mr. Bunting states that the pilei are pale coffee or cream coloured when young, slightly darker on the dorsal surface, and become darker with age.

There would appear to be some doubt whether this species is really *Marasmius scandens* Massee. It is certainly the common White Thread Blight of the Gold Coast, and Massee's figure of the cord would not fit any other species yet seen from that region. It is also the species sent to me as *Marasmius scandens* by Tudhope soon after Massee's publication of that species. But a specimen recently sent me from the Gold Coast as the co-type of the specimen sent to Massee is the tawny-brown Thread Blight described later in this paper. There would appear, however, to have been some mistake as regards this, as the latter specimen is on a cacao branch, 3 cm. diameter, whereas Massee figures his species on a branch, 1 cm. diameter. Hence, presuming that the figure is correct,

the two specimens would be growing so far apart that, even if they were from the same tree, they might be different species.

Massee's description of the sporophore makes the reference of this common White Thread Blight to *Marasmius scandens* still more uncertain. He described the sporophore of *Marasmius scandens* as "albidus", resupinate, and arising from the thread; and he gave a figure showing the pileus with an attaching weft of hyphae at the base. That description does not agree with any of the specimens since collected. The sporophores certainly arise from the cord, but in all the available examples they are distinctly stalked. Even minute specimens which show scarcely any traces of gills have a distinct stalk. It is unfortunate that Massee did not give details of the structure of the cord, and that there is no type specimen in the Kew herbarium. Massee described the pilei as 1 mm. diameter, but figured them "natural size" as 5 mm. diameter. There does not appear to be any doubt that the thread figured by Massee is the common Thread Blight of the Gold Coast, and consequently his name for the sporophore is retained here. But it is quite possible that, as in the cases of *Stilbum nanum* and *Cyphella Heveae*, the sporophore described by Massee had no relation to the thread.

The effect of this Thread Blight on cacao, etc., has been described by Bunting in the Annual Reports of the Department of Agriculture of the Gold Coast. It has been found on cacao, coffee, jak, camphor, cola, and *Carpodinus hirsutus* Hua, and is supposed,no doubt correctly, to have spread to cultivated plants from the cola and other plants in the jungle. It is said to have killed cacao, but Mr. Bunting in 1917 stated that he had not been able to find any authentic case of death resulting from its attack. The disease is easily kept in check by pruning off and burning affected branches. The dried specimens indicate that the fungus rapidly attacks the leaf.

Attempts were made to infect cacao trees at Aburi by contact, diseased material being tied to various parts of the cacao trees. Very slow growth resulted on the main stem near the base, and in some cases the fungus, after a slight growth, died. The maximum growth on stems occurred on a sucker, eight inches in diameter (?) at six feet from the ground, the mycelium ascending for a distance of about three feet in rather more than twelve months.

Bunting states that there is no macroscopic evidence of invasion of the cortical tissue by the fungus. Where twigs have been infected, the growth has generally been a little more vigorous than on the stems, a fact which he suggests may be accounted for by the accessibility of the leaves, some of which have been destroyed oy the action of the fungus. He also remarks on the possibility that there may be other

species of Thread Blight in West Africa in addition to *Marasmius scandens*. Attempts to infect cacao with the Thread Blight from cola were not successful.

(3) Malayan Thread Blight on *Hevea*.

Of this Thread Blight, I have examined specimens collected in the Federated Malay States by Mr. F. T. Brooks, and others kindly forwarded by Mr. R. M. Richards from Province Wellesley. In each collection there appears at first sight to be two forms.

In the first form, the mycelium occurs on branches about 1cm. in diameter, and is almost entirely confined to one side (Plate VII, fig. 2). The main cord runs longitudinally along the stem and gives off, at an acute angle, branches which anastomose with one another and with the main cord and form a network. On a stem 1.5 cm. diameter, there are two parallel main cords, the branches of which meet and fuse. The main cord is stout, up to 1.5 mm. broad, but its breadth may vary from 0.5 to 1.5 mm. within a distance of 3 cms. The lateral branches are usually narrower, and may be only 0.15 mm. broad. It frequently forms flat expansions, especially where two cords meet, but the membranous margin which occurs in other species is usually very narrow and often absent. The main cord is prominent, rounded above, up to 0.5 mm. thick, minutely tomentose, becoming glabrous. It is white at first, but acquires a brownish tinge when old. In longitudinal tangential section it appears white internally, but a transverse section shows a brownish tinge.

The cord internally is more or less felted or spongy, the hyphae being more interwoven than in other species in the outer layers. The hyphae are 1.5 to 3 μ diameter, and of the usual Thread Blight type. Knee bends are not common. The hyphae frequently bear oval swellings, sometimes two together (Plate IX, fig. 16). All the interior hyphae stain with eosin.

On the exterior of the cord the hyphae are encrusted with amorphous masses and minute granules, and the surface is covered here and there by an amorphous hyaline sheet in which the minute granules are embedded. Some of the hyphae at the exterior do not stain with eosin; these are usually minutely verrucose. There are no anker cells, and the cord is remarkable chiefly for the absence of any free clavate tips or very fine hyphae, such as occur in other species.

Thin-walled septate hyphae, up to 6 μ diameter, occur sparingly at the base of the cord. Near the growing point, where some of the hyphae are also thin-walled and septate, clamp connections may be found.

All the hyphae stain strongly with cotton blue.

One specimen shows this Thread Blight on a *Hevea* leaflet. The cord forms a small pad on either side of the mid-rib at the base of the leaf on its lower surface, and from each of these a cord runs along the mid-rib. One of these soon leaves the mid-rib and runs outwards the margin, thinning out so as to be scarcely visible. The other follows the mid-rib to the apex, crossing it from side to side, occasionally looping out over the leaf, and giving off a few very fine branches which spread outwards the margin. There is no general film over the under surface of the leaf. Consequently it would appear that this is not the Thread Blight described by Bancroft from Malaya.

Of the second form, one specimen, on a stem 1.3 cm. diameter, bears a main cord which runs irregularly along the stem, giving off fine branches at varying angles, but usually at a large angle. A second specimen (Plate VII, fig. 1) is on a stem 3.5cm. diameter, and the mycelium covers three-quarters of the circumference of the stem ; it runs in five main cords, more or less parallel to one another, but with sudden abrupt bends ; the angle of branching varies, but in general it is a large one. These bends are peculiar, in that the thick cord turns sharply to one side, but leaves a thin branch which grows on for a short distance in the original direction of the thread.

This second form looks different from that described above, because the cords are thinner, and the angle of branching is, on the whole, different. The microscopical examination of the cord, however, shows that it is identical in structure with the first, and it is most probably the same species.

Dr. C. Bernard has furnished me with specimens, apparently the same species, of Thread Blight on *Hevea* from Sumatra. The cord on a thin stem or on a petiole is in general unbranched, but on one petiole it forms a network. On reaching the leaf it divides fanwise and runs over the leaf in definite flexuose strands which make sudden bends. These bends are of the same peculiar form as those on the stem previously described. When two leaflets are fastened together by the fungus, it spreads from the point of attachment in a more copious development of somewhat diffuse radiating strands.

This species does not appear to cause damage to woody stems, as far as the available specimens show, but it kills the leaves when it runs over them. Its fructification is not known. In the absence of any Thread Blight in the type specimen of *Cyphella Heveae* it is impossible to say whether the latter name was intended to apply to this species.

(4). White Stem Blight.

Though this is not a Thread Blight, according to the planters' classification, in one of its forms, it nevertheless possesses a cord similar to that of the Thread Blights, and it becomes a true Thread Blight in in some situations. It has been found in Ceylon on *Hevea*, tea, and teak (Plate I, fig. 4).

In the case of *Hevea*, it usually occurs on semi-vertical branches, about 6 cms. diameter or less. Viewed from the ground, the affected branches look as though they had been whitewashed on the lower side, sometimes for a length of six feet, a white or greyish-white patch extending continuously along the branch and about half-way round it. Occasionally, white lines or bands, up to 1 cm. broad, extend in a zigzag fashion from the margin of the patch on one side, over the upper surface of the branch, and unite again with the patch on the other side, while in some instances similar white lines proceed longitudinally along the branch on its upper surface.

On examination with a hand lens, it is seen that there is no continuous sheet of mycelium over the whitened area. The surface is cracked and roughened as on normal *Hevea* stems and all the minute bark scales are clearly evident. If the specimen is left to dry in the laboratory, these scales fall off like flakes of bran.

On closer examination, one finds more or less rounded cords, up to 0.15 mm. diameter, running along the white patch. These usually are continuous only for a short distance, sometimes only for a length of a centimetre, and then enter a crack and divide up into hyphae which are lost between the bark scales ; but on the white lines and bands there is generally a continuous white cord running along the centre.

At the edge of the white patch, more especially at the upper edge, mycelium is sometimes plainly evident in very thin fimbriate strands, closely applied to the bark, which become shining and silvery. Fine strands of hyphae run in the cracks in the bark and spread out in sheets over the surface. These may be visible for a breadth of 2 cms. at the margin, and traces may be found as shining membranous patches, about 5 cms. from the edge, but in the specimens examined there is no indication of these patches over the general surface of the white area. It would appear probable that this development of mycelium may only occur under certain weather conditions. From the character of the bark it does not seem possible that this marginal mycelium is formed in the early stage of development of the white patch and weathers off later.

The cords on the white patch are composed of flexuose, more or less parallel hyphae, 2-2.5 μ diameter, thick-walled or solid, resembling

those of the Thread Blights in general. They may be solid for the greater part of their length, with a narrow lumen here and there. In the centre of the cord some of the solid hyphae are up to 5 μ diameter, and are composed of segments, with ends inflated up to 8 μ diameter, which readily separate from one another. The outer hyphae of the cord give off fine branches, 0.5 μ diameter, usually simple, which bear spherical or oval hyaline globules, up to 1.5. x 1 μ, either sessile on the hypha or at the apex of short lateral branches up to 2.5 μ long. These lateral branches are sometimes clustered, and they may be forked. The fine hyphae sometimes fuse into a hyaline film spreading over the bark from the edge of the cord, and, when old. the outer layer of the cord is a continuous thin amorphous sheet which is apparently formed from them.

Over the general surface of the white patch, hyphae, 2-5 μ diameter may be found, running singly or in small bundles in the cracks in the dead bark and giving off fine hyphae, 0.5 μ diameter, which permeate the dead cells.

The dead bark on the upper branches of *Hevea* consists of alternate layers of thin and thick-walled rectangular cells. In the specimen examined, the minute scales into which the outer layers were cracked consisted of an external layer of thin-walled cells, one cell deep, followed by a layer of thick-walled cells, four cells deep. Beneath these the bark was continuous, and was composed of a layer of thick-walled cells, 2 cells deep, followed by a layer of thin-walled cells, 2-3 cells deep, and then another layer of thick-walled cells overlying the living tissues. The walls of the thick-walled cells are up to 10 μ thick, with narrow pits.

The larger hyphae run in the cracks between the outer scales, and penetrate between the cells. The fine hyphae penetrate the cell wall and are abundant in the thin-walled cells of the outer layer of the scales, but occur more sparingly in the thick-walled cells where they pass from one cell to another *via* the pits. In the continuous bark layers, the mycelium is scanty ; here and there, the larger hyphae may be found running between the cells, and a few fine hyphae in the thin-walled cells. The mycelium has not been observed in the living tissues.

The white appearance of the stem is partly due to a sparse covering of mycelium which does not obscure the normal structure of the surface, but chiefly to the presence of minute bark scales which have been bleached and loosened by the fungus.

The fringe of mycelium at the edge of the white patch contains all the elements already described. Some of the hyphae there, however, are thin-walled and bear clamp connections. These clamp connections are usually situated opposite the point of origin of a branch, i.e., the

clamp connection arises, just below a septum, at one side of a hypha, and a branch in the corresponding position at the other side.

On *Hevea*, this species has been observed only on old branches, and consequently at a considerable distance from the leaves. There has therefore been no opportunity of noting its effect on the leaves of *Hevea*.

This fungus has been found on tea in the low-country of Ceylon. The appearance of the affected stems is in general similar to that in *Hevea*, but, the stems being thinner, the white patch encircles them. In some cases, the fungus began on stems about 2 cms. diameter, and ran upwards to the tips of the plucked shoots, whitening them uniformly all round. The cords of mycelium which overrun the white area are up to 0.2 mm. in breadth, often discontinuous, and usually flat and inconspicuous. On the thinner twigs they become stouter and more elevated.

Dead leaves or twigs which fall from the upper part of the bush and come in contact with the white patch are fastened to the stem by mycelium from the latter, whether in contact with a cord or with any part of the whitened surface.

At the base of a petiole, the fungus usually forms a small felted pad. From this it runs up the under side of the petiole in a rather broad tomentose cord and spreads out fanwise over the lower surface of the leaf in fine, somewhat feathery strands. The mycelium rarely extends over more than the basal half or two-thirds of the leaf.

On several branches on a bush on which most of the stems were whitened up to the apex, the white area terminated at a point about eight inches from the top, while the cord was continued upwards over the stem and the leaves. On the upper parts of these branches the fungus was merely an ordinary Thread Blight. The cord is stouter than that on the whitened patch and has usually a glabrous wrinkled surface. It branches at an acute angle, and rarely forms a network. Frequently the lateral branches of the cord spread out in small tomentose patches, or similar patches are formed at the side of the thread. At the base of a petiole it forms a pad, as in the form already described, and runs up to the leaf along the lower side of the petiole in a broad felted strand, but it does not divide up on the leaf blade into as many strands as in the former case, and in some instances the under surface of the leaf bears only three or four strands, of which one along the mid-rib may be as stout as the cord on the stem.

The effect of the fungus on the stem of the tea bush is similar to that on *Hevea*. The minute bark scales are loosened and fall off when the stem dries. The finer hyphae penetrate into the continuous cork

layer and pass from cell to cell through the pits. These hyphae have been found sparingly in the living cortical tissue and in the wood. As, however, this observation was made on stems which had been cut off and simply air-dried, there is some doubt whether this penetration occurs in the living stem. The thicker branches do not appear to be injured by the fungus, but the upper parts of the twigs may be killed.

When the mycelium spreads over the leaf, each strand is at first bordered by a narrow watery-green zone. The area covered by the mycelium soon dies, and, in the case of tea, becomes thin, papery, and yellow-brown, contrasting strongly with the terminal part of the leaf, which has died without being attacked by the fungus and is consequently dark brown. This appearance appears to be peculiar to this disease.

A somewhat different effect was noted on a few leaves, which had only recently been overrun by the mycelium. The strands on these were only about 30 μ broad, and would have been scarcely visible but for their effect on the leaf. Each was situated on a narrow watery green line, which, at fairly close intervals, expanded into circular areas, up to 0.2 mm. diameter. Consequently, the leaf bore watery green lines, beaded at close intervals, with a white line down the centre. When the leaf was dried, these circular areas became grey, but they are not covered by a pad of hyphae. Under each circular area the leaf is thickened. This is especially noticeable on the dried leaf, as the patches then form elevated areas, about 0.2 mm. diameter. The thickening is due to an increase in the number of cells, and the thickening of the cell walls, of the spongy parenchyma. These circular areas are often situated round a stoma, and stomata under or near a strand may be blocked by mycelium, though this is not universal. The hyphae may enter the leaf through a stoma or through the epidermis. On the other hand, a hypha may cross a stoma without entering the leaf. The hyphae penetrate the cells at random, and may be present in the palisade layer before the leaf shows any effect, except the watery green line.

After the death of the leaf, the cord or felted patch on the petiole and the strands on the leaf blade become thicker, grey-brown, and tomentose. The strands may spread out into compact felted patches, 2-3 mm. long and broad, especially along the mid-rib. They are then dense internally, often with a well-developed outer layer of free hyphae, which are pale brownish, flexuose and interwined, 3-4 μ diameter, and up to 0.4 mm. long. At the margin of the yellow patch, there is often a delicate film of hyphae, forming a thin sheet, which may appear powdery, owing to a strong incrustation of calcium oxalate on the free ends of the hyphae. When the leaf decays, the base of the petiole, or sometimes

the petiole and the mid-rib, remain attached to the stem by the mycelium at the base of the petiole and the cord along the mid-rib.

The fully-developed fructification of this species has not been obtained. Fructifications have been found on the leaves of a tea bush attacked by White Stem Blight, but, judging from the similar case of *Marasmius pulcher* they are most probably to be regarded as not completely developed. They occurred on leaves which bore fine white threads radiating from the base of the leaf or from a point at the edge of the leaf where the latter was in contact with, and united by the mycelium to, a whitened stem. The threads are narrow, up to 0.2 mm. broad, thin, silvery, branching frequently, and diminishing towards the tips. In places, the threads are only one hypha thick, the individual hyphae running side by side over the surface of the leaf united by a hyaline film. These threads do not appear to cause any damage to the leaf. The constituent hyphae are 3-4 μ diameter, regular, septate, with a thin, or moderately thickened, wall; they are more regular than the hyphae in the cord on the stem and approach the shape of *Corticium* hyphae.

The fructifications form small, white, circular or oval patches, up to 2 mm. diameter. They are attached to the leaf over the whole of their dorsal surface, and a white fringe of hyphae extends from them over the leaf. The upper surface is glabrous, and the margin slightly elevated. Sometimes they are incised on one side, but no trace of gills has been noted. The total thickness of the fructification is about 0.1 mm. The upper layer is composed of closely packed basidia, about 18 μ high, 4-5 μ diameter, four-spored, with hyaline, oval spores, 5-6 x 3 μ.

On the available specimens, there is no reason why this fructification should not be classed as a *Corticium*, but it would seem probable that it is really an imperfect development of a *Marasmius*. Similar pilei, lacking gills, occur in *Marasmius pulcher* and *Marasmius scandens*.

It is remarkable that the leaves which bear these fructifications of the White Stem Blight do not exhibit any signs of injury by the fungus. This behaviour is similar to that of the *Corticium* which causes Black Rot of tea.

The specimen on teak consists of the terminal portion of a leafy shoot. The young stem is not whitened, but the specimen is insufficient to show whether this occurred on the older woody stem below. The cord on the stem is stout, about 0.3 mm. broad, elevated, continuous, branching and forming a network, sometimes with byssoid patches spreading from the cord. On the older parts, the cord is dark-brown or blackish externally, but the hyphae are not coloured.

The effect on the leaves is the same as on tea, the part of the leaf covered by the mycelium, about half the leaf, turning yellow-brown.

The mycelium forms a pad at the base of the petiole and travels up the stout petiole in one or more cords which branch and anastomose. Similarly, the mid-rib may be covered with a network of cords, while branches from these travel outwards along the prominent lateral veins. From the latter, hyphae spread out over the surface of the leaf in finer strands or thin, byssoid patches. In some instances, the restriction of the main cords to the veins is very marked, but in others the cords run at random from the mid-rib or from the base of the leaf. Compact, tomentose, grey-brown patches are frequent, especially by the side of the mid-rib.

Though no whitening of the stem has been observed in the case of teak, there is little doubt, from the structure of the thread, etc., that the fungus in this case is the same as that of the White Stem Blight of *Hevea* and tea.

(5) Brown Thread Blight, Ceylon.

This Thread Blight was found in the Botanic Gardens, Peradeniya, on an exotic tree, *Garcinia cornea* L. It occurs towards the ends of the branches, on twigs about 5 mm. diameter or less.

The cords are somewhat flattened, at first white, becoming pale brown, with a white, spreading, pruinose margin. The brown thickened cord is about 0.5 mm. broad, and the total width, including the thin margin, about 1 mm. It runs more or less longitudinally along the branch, branching freely and anastomosing to form a network. Here and there it expands into rather thick, pale brown or fawn, tomentose patches. It passes from the stem to the leaf stalk, but has not been observed to spread over the leaf. The brown cord is looser than in other Thread Blights : its surface, especially towards the growing point, may be longitudinally fibrillose, and its constituent hyphae, or at least those in the interior, separate readily when the cord is teased out.

The main hyphae of the cord are 2-3 μ diameter, yellowish-brown, thick-walled or solid. They are more regular than in other species, but have the same general structure. Swellings with a narrow internal cavity (? old clamp connections) are common, and intercalary oval swellings, up to 20 x 12 μ, with a large cavity, which somewhat resemble anker cells, occur in the solid hyphae (Plate IX, fig. 17). On the exterior of the thread, the hyphae bear minute hyaline granules, and the same granules occur in small masses between or over them. These hyphae stain with eosin, but the granules do not.

Thin-walled, septate hyphae not been observed at the base of the thread. The extreme basal layer is hyaline, does not stain with eosin,

and appears to be composed of disorganised hyphae. Towards the growing point, septate hyphae, 3 μ diameter, occur, and these bear clamp connections.

In the film at the side of the cord, the hyphae are hyaline, 1-2 μ diameter, thick-walled or solid. All the film is strongly encrusted with irregular masses of calcium oxalate. The hyphae are strongly encrusted with minute hyaline granules, and bear free clavate branches, up to 10 μ long, similarly encrusted, or spinulose. Small masses of the same granules also occur between the hyphae. The thick-walled hyphae bear, somewhat sparingly, fine hyphae, 0.5 μ diameter, which may be simple or branched. The main hyphae of the film form a network which fuses into a continuous sheet. In many cases, hyphae which diverge from the main cord branch at their extremities, and the branches expand into hyaline films (Plate IX, fig. 18). The spaces between the hyphae are filled by a hyaline amorphous membrane, in which fine hyphae and innumerable granules are embedded.

This Thread Blight does not appear to injure the tree. No fructification has yet been observed.

(6) Brown Thread Blight, West Africa.

Three gatherings of this species on cacao and kola were included in a collection of Thread Blights kindly forwarded to me by Mr. R. H. Bunting.

The thread occurs on the stems and leaves. On the latter it branches at a fairly wide angle and spreads out over the leaf, sometimes extending over nearly the whole of a cacao leaf. In one gathering, the thread is on the upper side of the leaf, but in the other two it is on the lower side.

The thread is tawny brown, slightly longitudinally fibrillose. It is not bordered by a white film, as in the corresponding Ceylon species. The hyphae are yellow-brown, 2-4 μ diameter, of the usual Thread Blight shape, but with walls only moderately thickened. Septa are frequent, and many hyphae show normal branching, the lateral branch arising just below a septum. Hyphae which spread out from the cord over the leaf tend to fork and form expansions at their extremities, but this is not as well-marked as in the parallel Ceylon form. Fine hyphae have not been observed. The yellow-brown hyphae do not stain with eosin.

One example bears immature pilei, and fragments of mature pilei, attached to the thread. The immature pilei are small pezizoid structures, cup-shaped, 0.2 mm. high, 0.3 mm. diameter, white pruinose externally. The fragments are strongly brownish white pruinose externally, with

a red-brown hymenial layer. The outer (upper) surface bears irregular hyphae, 4 μ diameter, rough with projecting points or elongated spines, or bearing short bristle-like appendages, and encrusted with calcium oxalate.

It is probable from the specimens available that the fructification of this species is a *Marasmius*.

(7) Purple-brown Thread Blight, West Africa.

Two examples of this species on cacao were present in the collection of Thread Blights from the Gold Coast, one on a stem and the other on a leaf. On the stem, the cord is unbranched and runs irregularly along it. On the leaf it occurs on both sides, but chiefly on the upper, radiating from a point near the margin where a dead twig is attached to the leaf. The colour is dark purple-brown, appearing almost black (Plate VI, fig. 2).

The thread on the leaf, towards the point of origin, is stout, rounded, up to 0.4 mm. broad, with a broad thin margin, up to 0.6 mm.wide. It branches repeatedly, the branches becoming progressively finer and pale-brown towards the tips. The exterior hyphae are yellow-brown by transmitted light, and form a continuous cortical layer. The internal hyphae are hyaline, flexuose, 2 μ diameter, thick-walled or solid. The thin margin is chiefly a network of hyphae, united by an amorphous film which is either brown or hyaline. A few clavate branches bearing short fine hyphae, are also present. In some places, the hyphae at the margin of the thread are united laterally into a sheet which recalls the cover of a Microthyriaceous perithecium, but in others they form a wide-meshed network.

No fructification of this species has been observed. In the differentiation of the hyphae into a coloured outer layer and a hyaline inner tissue, the cord resembles that of the Horse-hair Blights.

(8) Brown Thread Blight on Cacao, West Indies.

A specimen of a brown Thread Blight on cacao was kindly sent me from the West Indies by Mr. W. Nowell. It had been preserved in alcohol, and the colours described are those after drying.

The cord is on a stem 5-6 mm. diameter, along which it runs more or less regularly, giving off branches to the lateral twigs. It is about 0.4 mm. in diameter, somewhat elevated, rounded above, dark red-brown, smooth. Internally it is white, or brownish white. The hyphae are

3-5 μ diameter, thick-walled or solid, flexuose, with knee bends, and suddenly inflated here and there from 3 to 4 or 5 μ, but without any large swellings. There are no special fine branches in the available specimen, and neither septa nor clamp connections were found, even in the basal layer. The red-brown colour is due chiefly to a brown deposit on or among the outer hyphae of the thread.

The cord bears hemispherical, or irregularly pulvinate, cushions, up to 4 mm. diameter, wide apart, or close together and confluent. These are white, spongy, with the outer layer interwoven into a more or less glabrous sheet. The hyphae of which they are composed are loosely intertwined, 3-4 μ diameter, thin-walled and collapsing, or thick-walled with a narrow lumen, or solid, flexuose and irregular in diameter. Septa were not found.

The hyphae of the cushions are similar to those of the thread. They stain with cotton blue, but not with eosin.

In general appearance, and in their spongy nature, the cushions of this species resemble those of the *Corticium* on tea from Sumatra. But the thread is a different colour, and the hyphae differ completely, being those of a *Marasmius* Thread Blight, not those of a *Corticium*.

This species resembles *Corticium Stevensii*, which has been recorded from the West Indies, in the colour of the thread. The cushions, however, differ in colour on the available specimen, and they are not sclerotia, but consist of merely loosely interwoven hyphae. Further, the hyphae of the thread of *Corticium Stevensii*, as described by Stevens and Hall, are regular and septate, as is usual in the *Corticium* Thread Blights, while in the present species they are irregular and do not show septa.

It would appear, therefore, that there are two brown Thread Blights in the West Indies, which resemble one another closely in macroscopic characters, but differ in the character of their hyphae.

SUMMARY.

In the Thread Blights of the Eastern Tropics which have been found to belong to species of the genus *Corticium*, a large proportion of the hyphae of the cord are thin-walled and of normal structure, while the remainder, though thick-walled, are regular and have a distinct lumen and unthickened septa. Solid hyphae have been observed in one species of this group. A thin hyaline membrane unites the hyphae in expansions at the side of the cord, or in membranous coverings on the leaves, and assists in fastening the mycelium to the host.

A progressive development of the mycelium may be traced in these aerial species of *Corticium*. In the species which causes the Black Rot

of tea, the hyphae are thin-walled and do not coalesce to form a visible thread. In *Corticium Theae*, the hyphae unite into a cord, and the majority of the hyphae in the cord are thick-walled. Black Rot of tea is essentially a wet-weather disease, and the fungus on the stem appears to die off when the rains cease. In *Corticium Theae*, the thread is persistent, though it shrinks on drying.

It appears to be possible, at least in the East, to distinguish the *Corticium* Thread Blights from other species by the character of the hyphae.

The other Thread Blights described in this paper agree with one another, and differ from the *Corticium* Thread Blights in having the greater part of the hyphae of the cord irregular, thick-walled or solid. In these hyphae, septa and clamp connections are, in general, lacking. Berkeley stated that the hyphae of the species examined by him had no joints, as far as he could ascertain. Where the fructification is known, it has been found to be a *Marasmius*, and consequently this group has been designed Marasmioid Thread Blights, though it has to be admitted that in the majority of these forms the fructification has not yet been determined. The remainder of this summary refers to these Marasmioid Thread Blights.

Thin-walled hyphae may be found, in most species, at the base of the cord, and (though not universally in the one species) at the growing point, or in the film at the side of the cord and on the leaf, and in some instances, on the exterior of the thread. The latter occurrence is perhaps dependent upon weather conditions, i.e., a period of high rainfall. These hyphae are septate and may bear clamp connections.

Cases of partial absorption of the septa may be observed in the thin-walled hyphae (Plate IX, figs. 10, 12), and it appears probable that all the septa are absorbed before the wall of a hypha is notably thickened. The growth in thickness of the cord would appear to be accomplished by the addition of hyphae from below, the hyphae being subsequently converted from thin-walled into thick-walled, or solid, hyphae. But as some of the hyphae at the base of the cord are, in some species, more than double the diameter of the thick-walled hyphae, it would appear that these hyphae may remain permanently as thin-walled basal hyphae, possibly serving for transference of food and constituting a permanent meristematic tissue.

The clamp connections of the thin-walled hyphae are probably represented by swellings on the solid or thick-walled hyphae. Swellings which have a narrow lumen, as in Plate IX, fig. 17 (right) and 2 (right),

are strongly suggestive of thickened clamp connections, the lumen representing the space between the parent hypha and the curved connecting link.

On the solid, or thick-walled, hyphae, branches are difficult to find. The thin-walled hyphae branch at a medium angle. From examples, such as that in fig. 11, Plate IX, it appears that when the walls of the hyphae become thickened, the lateral branch or the parent hypha may degenerate, at least near the fork. The position of the former bifurcation is then indicated by an angular projection or a knee bend. Fig 11 shows an angular projection in the lower part of the hypha, and a degenerating branch arising from a similar projection above. In a few instances however, both the parent hypha and the branch become thick-walled (Plate IX, fig. 2).

In nearly all the species examined, the hyphae at the exterior of the cord give off very fine branches, less than 1 μ in diameter, either simple or branched, and apparently solid. In one species, *Marasmius pulcher*, these fine hyphae bear branches more or less in whorls, and thus resemble conidiophores. In all the species which possess these fine branches, they are especially abundant in the narrow film at the side of the thread, and in the film on the leaf. In the latter, they appear in the earliest stage of its formation.

At the exterior of the thread, all the hyphae are usually more or less encrusted with minute, hyaline, solid globules. These occur both on the thick-walled hyphae and on the very fine hyphae, and on the latter they resemble conidia.

The globules and the fine hyphae at the exterior of the cord become embedded in a thin, hyaline amorphous membrane. This occurs also at the base of the film at the side of the thread or on a leaf. It is probable that this membrane is formed by an excretion from the hyphae, and that the fine conidiophore-like hyphae are in some way connected with this excretion. The nature of this membrane and the globules has not been ascertained. The membrane does not disappear in alcohol, but it appears to be dissolved to some extent, as specimens of Thread Blights preserved in alcohol readily separate from the host plant.

In staining with eosin, the globules, the finer hyphae, and the amorphous membrane do not stain. In the Thread Blights which possess anker cells, the walls of the remaining hyphae do not stain with eosin, but in those which lack anker cells, the walls of these hyphae, in general, take the stain. In the Malayan Thread Blight on Hevea, however, which is one of the species without anker cells, the inner thick-walled hyphae stain with eosin, but those on the exterior of the thread, which are rough with hyaline globules, do not stain.

The occurrence of very thin, hyaline, amorphous membranes is a fairly common phenomenon in tropical fungi. Burt has noted it in *Corticium Koleroga*; in discussing (and rejecting) Cooke's statement that the fertile patches of this species are gelatinous, he remarks, "However, when, in the case of other collections, I moisten the fructification on the leaf and detach it from the surface of the leaf with the point of a scalpel, I do detect in places from along the very surface of the leaf a very delicate transparent membranous structure suggestive of the hypothallus of such a myxomycete as *Stemonitis*, but much more tenuous and delicate." It is a membrane of this nature which makes the first stages of the Thread Blight on a *Strobilanthes* leaf appear silvery when viewed obliquely. It may be noted that if leaves bearing *Corticium Koleroga* are preserved in alcohol, the fructification floats off the leaf as a thin film when the bottle is shaken. That this film is in some species adhesive at some stage of its formation is evident from the foreign bodies, fungus spores, etc., which are found adhering to the thread.

Membranes of this character are found commonly in fungi which occur on leaves, but are not parasitic, or only feebly parasitic, on the plant. In Horse-hair Blight (*Marasmius equicrinis* Berk.),the hyphae of the attaching discs are united by a membrane of this character, and the mycelium separates from the host when the specimen is preserved in alcohol. In *Aschersonia* and *Hypocrella*, the hypothallus often consists of a similar membrane. In the species of *Torrubiella* on scale insects, the basal layer of the stroma and hypothallus is membranous, and in some species the membrane contains globules and fine hyphae similar to those which occur in the membranes of the Thread Blights. In the *Microthyriaceae*, a similar membrane sometimes extends over the leaf from the minute perithecia, uniting the perithecia over the greater part of a leaf; in some cases, a few hyphae are embedded in it, forming a wide-meshed network, in others it is wholly amorphous.

It may be suggested that the substance which forms these membranes is similar to that which causes the varnished surface of *Fomes lucidus*, etc. In *Fomes lucidus*, as it occurs in the tropics, the developing pileus is at first white and its surface is not laccate. As it increases in size the older parts become yellow and laccate, and the colour gradually changes to the red or mahogany of the mature pileus. Thus, in an actively growing pileus, the margin for a breadth of about one inch will be white and not laccate, the zone immediately behind this will be yellow and varnished, while the older part will have the normal character of the mature pileus. In *Polyporus colossus* the condition is the same; the growing margin is not laccate. I am not aware that the method of formation of this laccate crust has been investigated.

With regard to the association of the finer hyphae with membrane formation, and their resemblance to conidiophores, the following parallel may be recorded. *Fomes lamaoensis* Murr. clothes the roots of the plants it attacks with a tawny brown, interwoven mycelium. When old, this mycelium acquires a thin, brittle, black, outer crust. In some cases this crust bears powdery brown patches, and these are found to consist apparently of branched conidiophores, bearing terminal, oval, yellow-brown conidia. Further examination, however, shows that these apparent conidia are solid globules. The full investigation of this has not yet been completed, but it appears that these hyphae and globules normally take part in the formation of the black crust. Where the powdery patches occur, the crust has apparently been formed at a deeper level in the mycelium and the pseudo-conidiophores have been left outside it, just as, in the formation of some sclerotia from a weft of hyphae, e.g., *Sclerotium stipitatum*, only the inner hyphae form the sclerotium, the outer hyphae being cut off and ultimately dying.

Thread Blights are not necessarily confined to bushes growing under shade. The parasitic species on *Gymnosporia* occurs in the Botanic Gardens, Henaratgoda, on an isolated bush in the open, exposed to full sunlight, in a district which is subject to a partial drought for two months in the year.

That the superficial mycelium should be able to survive such conditions is no doubt due to the character of the hyphae of the thread. The majority of the hyphae which compose the thread are thick-walled or solid,—are, in fact sclerotioid, Thin-walled hyphae occur normally only towards the base of the thread, in which situation they will be protected from dessication by the compact mass of sclerotioid hyphae.

The primary function of the hyaline membrane is most probably to attach the cord to the host plant, as in other species of fungi. But in the Thread Blights, this membrane also covers the cord, at least in the older parts. In that situation, it may be presumed that it serves to hinder evaporation from the cord during dry weather, and thus furnishes another means of protection from dessication.

It is quite common, especially on tea, to find the Thread Blight cord originating from a point where a dead leaf bearing the mycelium has become attached to the stem ; and there is no doubt that the dispersal of infected leaves by the wind is effective in extending the local distribution of these fungi. But that is not true of all infections, and it is doubtful whether that method would be effective over long distances. It would appear more probable that the appearance of Thread Blight in localities hitherto unaffected is due to a distribution of spores. It may

be noted that, in general, the spores of the tropical species of *Marasmius* germinate readily ; they will germinate in a spore print left overnight.

No further evidence has been obtained as to the nature of the structures known as anker cells.

Most of the Thread Blights are parasitic, though they do not cause much damage except on leaves and young stems. *Marasmius pulcher* is epiphytic.

The fully-developed fructification of the marasmioid Thread Blights has been found in the case of two species only, viz. *Marasmius pulcher* (B. & Br.), of Ceylon and India, and *Marasmius scandens* Massee, of West Africa. In the case of White Stem Blight, a fructification has been found, which is probably an imperfectly developed *Marasmius*.

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EXPLANATION OF PLATES.

Plate I. Fig. 1. *Corticium* sp., with hyphal cushions, on tea, nat. size.
Fig. 2. *Corticium Gardeniae*, on *Rubiaceae*, x 4/5.
Fig. 3. *Corticium Theae*, on tea, x 4/5.
Fig. 4. White stem blight, on tea, natural size.

Plate II. Effect of Black rot on Coca ; leaves on the left not attacked ; nat. size

Plate III. Thread Blight on old and young stems of *Gymnosporia*, nat. size.

Plate IV. Fig. 1. Zimmermann's cobweb fungus on tea, nat. size.
Fig. 2. Young fructifications of *Marasmius pulcher*, on *Garcinia*, nat. size.
Fig. 3. Thread Blight (*Marasmius pulcher*) on *Garcinia*, nearly nat. size.

Plate V. Fig. 1. Thread Blight (*Marasmius pulcher*) on nutmeg leaf, natural size.
Fig. 2. Thread Blight (*Marasmius pulcher*) on nutmeg, x $\frac{1}{2}$.

Fig. 3. Thread Blight (*Marasmius pulcher*) on old tea stem, x $\frac{1}{4}$.

Fig. 4. Thread Blight (*Marasmius pulcher*) on nutmeg, passing from a dead twig to a leaf, x $\frac{1}{2}$.

Plate VI Fig. 1. Thread Blight (*Marasmius scandens*) on cacao stem, x 5/6.

Fig. 2. Purple-brown Thread Blight on cacao leaf, spreading from a dead twig, x $\frac{3}{4}$.

Plate VII. Fig. 1. Thread Blight on *Hevea*, x 6/7.

Fig. 2. Thread Blight on young *Hevea* stem, x 5/8

Plate VIII. Fig. 1. *Marasmius pulcher*, imperfect fructifications (*Cyphella pulchra* B & Br.) on dead nutmeg leaf, x 8.

Fig. 2. *Marasmius scandens*, on cacao leaf. x 2.

Plate IX. Fig. 1. Hyphae of *Corticium Gardeniae*, that on the left with thickened walls but comparatively thin septa, x 500.

Fig. 2. Hyphae from the Indian parasitic Thread Blight on tea, showing various stages of thickening of the walls. Starting from the left, the first two are moderately thick-walled; the third solid, except for a narrow lumen over part of its length; the fourth and fifth solid, the latter in irregular joints; the sixth branched and moderately thick-walled; the seventh branched and in part solid; the eighth solid; the ninth solid, except for a small cavity situated below a lateral swelling (? a clamp connection). All x 800.

Fig. 3. Anker cells from the Indian parasitic Thread Blight on tea, x 450.

Fig 4 Toothed hyphae from the Indian parasitic Thread Blight on tea, x 1,000.

Fig. 5. Fine hyphae, with granules, from the Indian parasitic Thread Blight on tea, x 400.

Fig. 6. Clavate tip from the Indian parasitic Thread Blight on tea, x 1,000.

Fig. 7. Anker cells of the Javan Spinnenwebeziekte (after Zimmermann).

Fig. 8. Toothed hypha from the Javan Spinnenwebeziekte (after Zimmermann).

Fig. 9. Anker cells from the Ceylon parasitic Thread Blight on *Gymnosporia*, x 450.

Fig. 10. Stout thin-walled hypha, with septum partly

absorbed, from the Ceylon parasitic Thread Blight on *Gymnosporia*, x 800.

Fig. 11. Hypha from the cord of *Marasmius pulcher*, with degenerating side branch, x 800.

Fig. 12 Branched hypha from the cord of *Marasmius pulcher*, showing absorption of septum, x 800.

Fig. 13. Solid hyphae from the cord of *Marasmius pulcher*, x 800.

Fig. 14. Ultimate fine branches of the hyphae of *Marasmius pulcher*, x 1,000.

Fig 15. Inflations on the hyphae of *Marasmius scandens*, x 600.

Fig 16. Parts of hyphae from the Malayan Thread Blight on *Hevea*, x 600.

Fig. 17. Inflations on the solid hyphae of the brown Thread Blight on *Garcinia*, Ceylon, x 400.

Fig. 18. Terminal portions of the hyphae from the margin of the brown Thread Blight on *Garcinia*, x 750.

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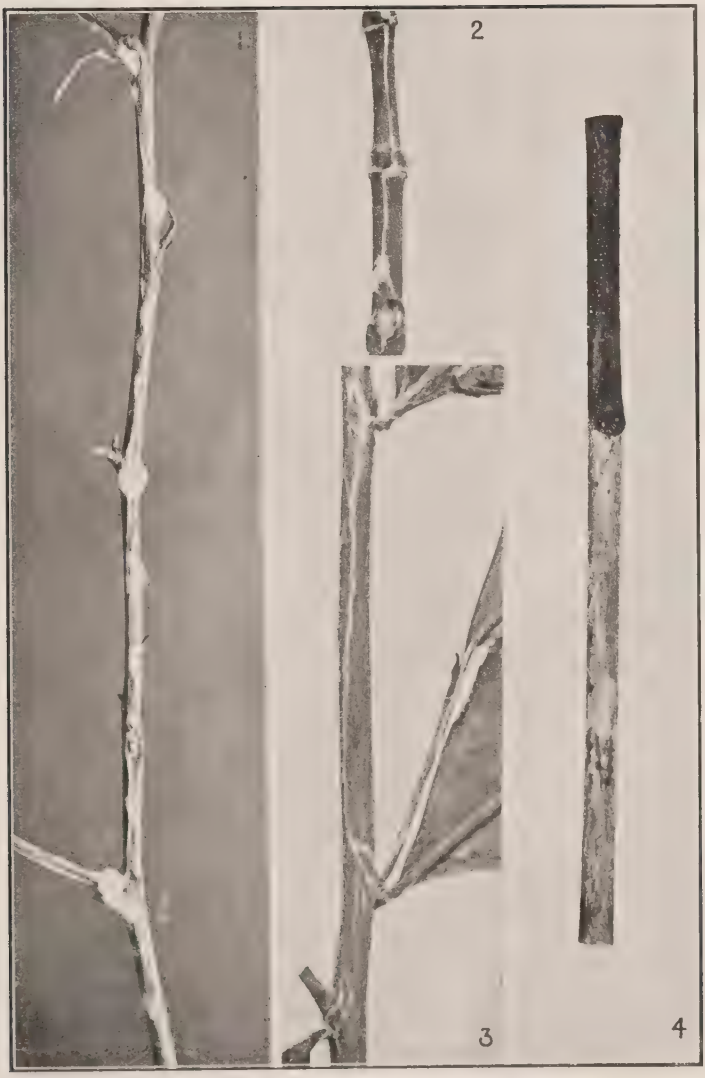

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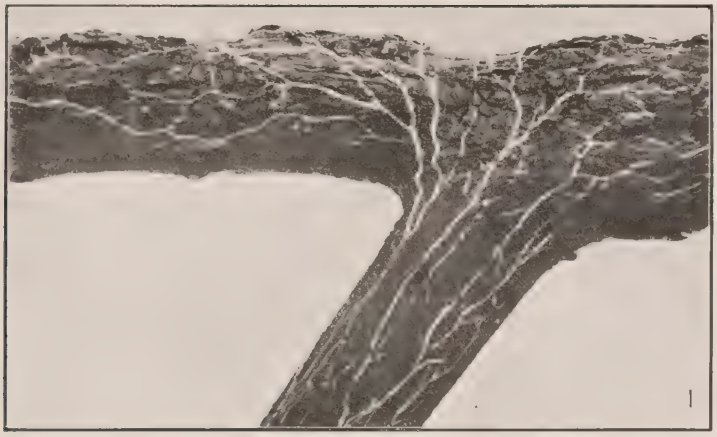

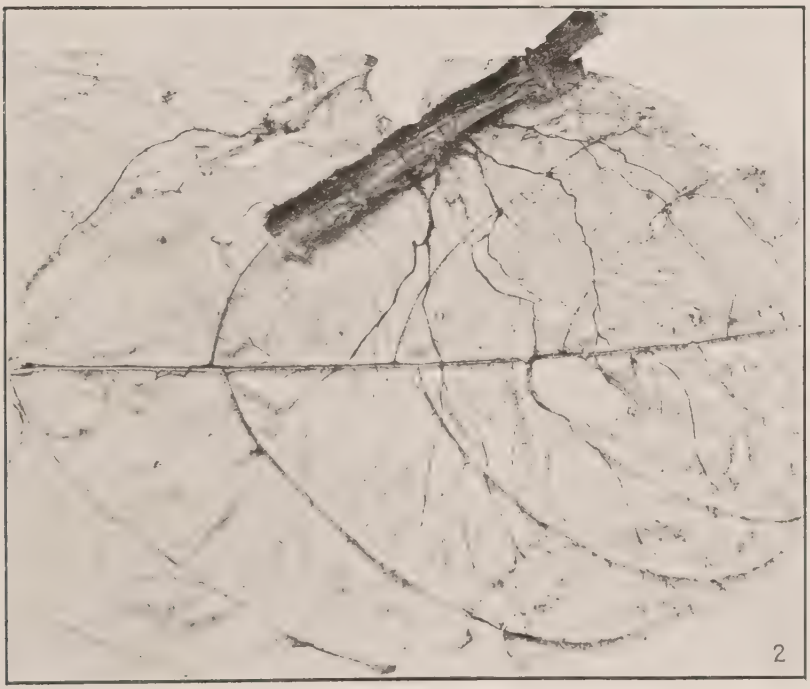

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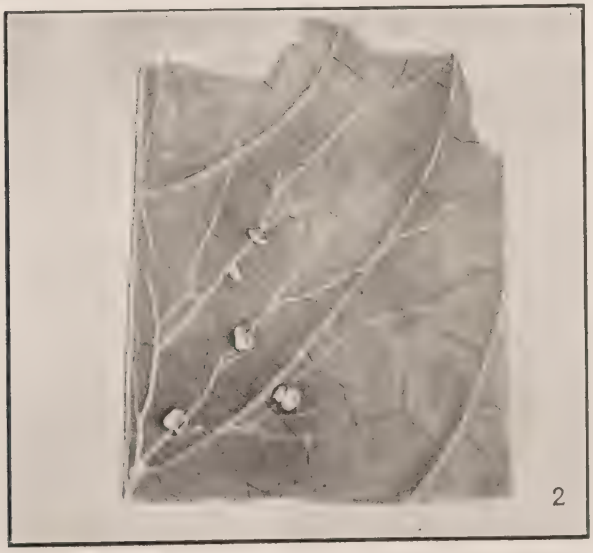

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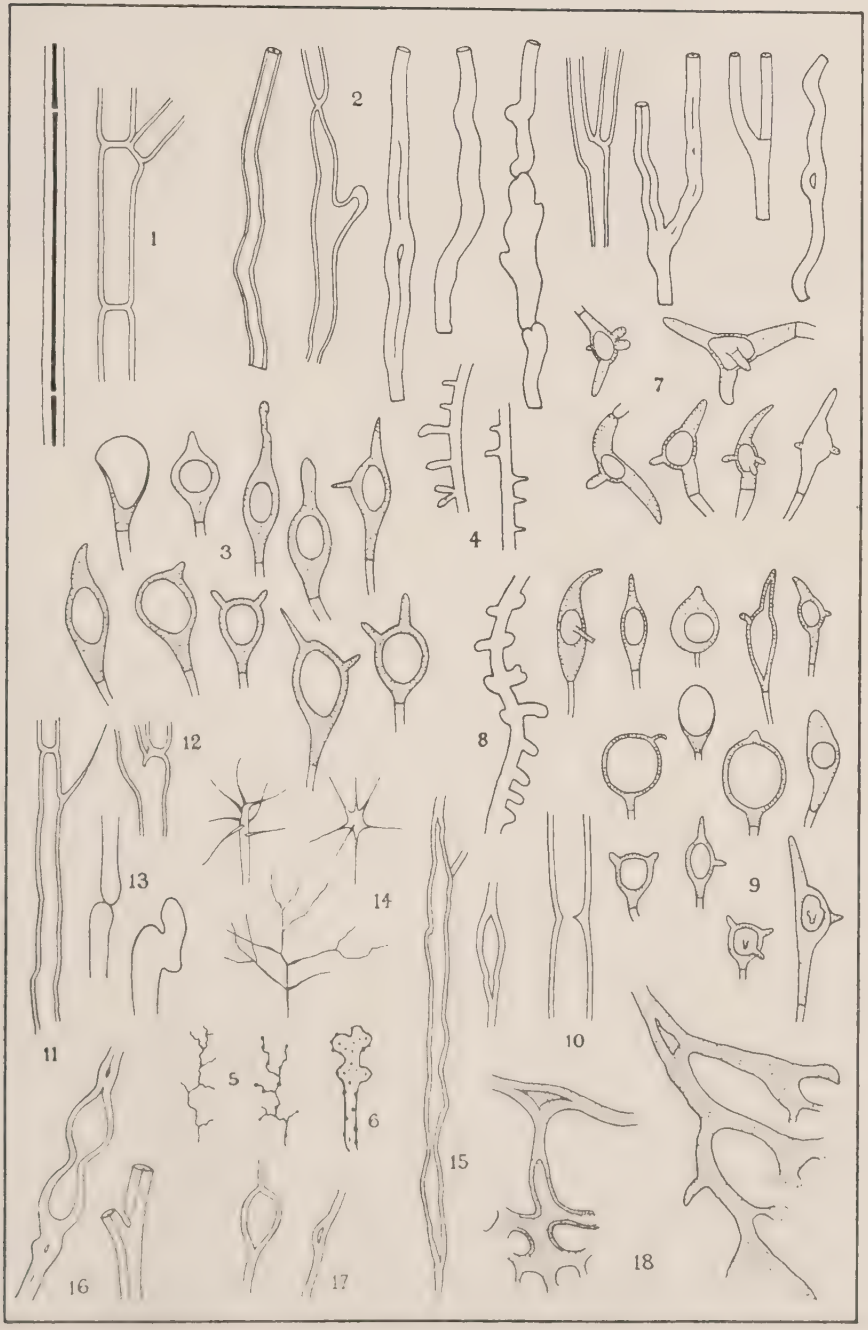

THREAD BLIGHTS.

Phytophthora Faberi Maubl.

BY

C. H. Gadd, B. Sc.

WITH ONE PLATE.

History

Pod rot is one of the oldest and best known diseases of the cacao tree. A quotation of Dr.de Verteuil, given by Rorer (29), indicates that the presence of this disease had been observed in Trinidad as early as 1727. By the end of the nineteenth century, owing to its destructive nature, the disease had attracted attention in all the principal cacao-growing countries of both the East and the West Indies.

In 1899, after an examination of diseased pods from Trinidad, Massee (15) reported the presence of a *Phytophthora* on all the pods sent, and referred it to the species *P. omnivora* de Bary. Later, the fungus was studied by others notably von Faber (32), Rorer (29), and Coleman(9), who expressed doubts as to the correctness of Massee's identification. As a consequence of von Faber's careful morphological study of the fungus, Maublanc (16), in 1909, described it as a new species. He stated "Il est certain que le champignon du Cacaoyer presente des grandes affinités avec le *Phytophthora Cactorum*, mais d'après les récentes observations de von Faber, il parâit bien en être diatinct et nous croyons devoir le considerér comme une espèce speciale sous le nom de *Phytophthora Faberi* nov. sp." It is by this name that the fungus is now universally known

Usually associated with the pod disease of cacao is a disease of the stem, to which the name 'canker' has been applied. Petch (23) was the first to question the parasitism of the various Nectrias and Calonectrias to which the cacao canker had been ascribed in various countries. In 1910, Rorer (29) isolated a *Phytophthora* from cankered bark, and was able by inoculation experiments to prove that the *Phytophthora* which causes cacao pod rot is also the cause of canker, and that the diseased pods serve as the chief source of infection of the tree. Inoculation experiments carried out in Ceylon by Petch (24), confirmed Rorer's

conclusions. It is now generally agreed that the cause of pod rot and canker of cacao in all cacao-growing countries is *P. Faberi*.

Claret-coloured canker and pod rot of *Hevea* first appeared in Ceylon in 1903 (7). Concerning the pod rot of Hevea, Petch (21) in 1905 stated, "The disease is due to a parasitic fungus similar to, if not identical with, hat which causes the decay of cacao pods." In 1910 (24) after a series of inoculation experiments on *Hevea* with *Phytophthora* spores obtained foom cacao, he concluded that "The canker and pod disease of *Hevea* arre both caused by *Phytophthora*, and that the species is the same as that which causes pod disease and canker in Cacao, viz., *Phytophthora Faberi* Maubl." Later (25), (26), he concluded that the leaf fall which often follows the fruit disease, is caused by the canker fungus. Thus in Ceylon, diseases of the fruit, cortex and leaves of *Hevea* are attributed to *P. Faberi*.

Similar conclusions were reached by Rutgers (31), in 1917, after a series of inoculation experiments with *P. Faberi* on *Hevea* in Java. Concerning the virility of *P. Faberi* on *Hevea* pods, he says, "When starting the experiment there was not one diseased fruit in the plantation; after three weeks the experiments had to be stopped because locally 50 per cent of the fruits were attacked, many of them being quite covered with *Phytophthora* conidia." He also demonstrated that the same fungus was a cause of stripe canker, which in Ceylon is known by the name of Bark rot or Black thread.

In 1906, Petch (22) reported a decay of breadfruit due to a *Phytophthora* which he considered to be the same as that on cacao pods and *Hevea* fruits.

In 1916, a *Phytophthora* on papaw fruits (*Carica Papaya*) was reported from the Philippines (20). Microscopic examinations and infection experiments led to the conclusion that, in both the cacao and papaya diseases, *Phytophthora Faberi* is the primary agent. In Ceylon, a similar fungus was isolated from diseased papaw fruits in 1921 (13), and from a cankered lesion at the base of the stem of a papaw tree in 1922. As far as the writer is aware this is the first record of *P. Faberi* attacking papaw stems.

In 1912, Rutgers isolated a *Phytophthora* from the nutmeg tree (*Myristica fragrans*) in Java, and after growing it in pure culture concluded that it was identical with the species on cacao. The presence of a *Phytophthora* on nutmeg had previously been recorded by Zimmermann (34) who identified it as "*Phytophthora* spec. (*Ph. omnivora* de Bary ?)." His description of the fungus suggests that it was identical morphologically with *P. Faberi*.

P. Faberi was isolated from a typical case of bud rot of coconuts by Reinking (27) in 1919. As a result of infection experiments and cultural studies, he concluded that "the fungus causing coconut bud rot is identical with the organism which produces black rot of cacao pods,

canker of cacao, fruit rot and canker of *Hevea* rubber and rot of papaya fruit."

Phytophthoras, similar morphologically to *P. Faberi*, have been isolated by the writer from *Dendrobium Maccarthiae* and *Odontadenia speciosa*. In both cases, the plants had been growing in a garden surrounded by rubber trees severely affected by pod rot and leaf fall. The orchid had wilted and died suddenly as a result of the fungus having established itself in the stem. The leaves, flowers and buds of *Odontadenia* were attacked, and the shoots died back rapidly. The prevalence of the *Phytophthora* on *Hevea* at the time suggested that infection had come from that source. Inoculation experiments showed that the strains isolated from *Dendrobium* and *Odontadenia* readily attacked *Hevea* pods, and it was concluded that they were of the same species as that occurring on *Hevea*.

In addition to the above enumerated hosts on which *P. Faberi* occurs in nature, the fungus has been successfully inoculated on to numerous other plants by Coleman, Reinking, and others. The omnivorous habit of this fungus is therefore evident, and it must be regarded as one of the most destructive known.

Scope of Investigations

As no definite criteria for the identification and separation of the species belonging to the genus *Phytophthora* are known, considerable reliance has to be placed on the mode of development and size of the oospores, the measurements of sporangia and chlamydospores, and the results of cross inoculation experiments. The arrangement of the sexual organs and the size of the oospore have been found to be the best character on which to base the natural separation of species. In the absence of oospores, the delimitation of species becomes more difficult owing to the great variability in size of the sporangia and chlamydospores. Oospores of *P. Faberi* have not been found in nature, nor obtained in pure culture; consequently considerable reliance has been placed on general morphological characters and on inoculation experiments, for the determination of this species.

Concerning the validity of cross inoculation experiments in delimiting species of *Phytophthora*, Wilson (33) states:—"A comparison of the results published by various authors tends to throw decided doubt on the value of this method of delimiting species in this genus, as practically any species of *Spermatophyta*, which is in nature subject to the attack of any *Phytophthora*, is likely under laboratory conditions to be more or less severely attacked by almost any other species." The use of certain

morphological characters alone is liable to equally strong objections owing to their variable nature.

On the publication of Reinking's investigations on the cause of coconut bud rot in the Philippines, Butler (5) drew attention to the possible identity of *P. Faberi* with *P. palmivora*, which had previously been demonstrated to be the cause of bud rot of Palmyra and coconut palms in India (4).

In Jamaica, Ashby (1), (2), isolated from coconut palms affected by bud rot, a species of *Phytophthora* which Butler, from cultures sent to him, identified as *P. palmivora*. Ashby's comparison of pure cultures of the cacao and coconut Phytophthoras showed that the macroscopic growth and microscopic characters of the mycelium, the size and shape of the sporangia, and the size of the resting spores (chlamydospores) were all very much alike, though minor differences were observed. His inoculation experiments, however, indicate that the cacao *Phytophthora* does not readily attack the coconut, and that cacao pods cannot be rotted by the form from the bud rot of the coconut. In a later publication (3), he concluded that the Phytophthoras from coconut and cacao must be regarded as distinct species, viz. *P. palmivora* and *P. Faberi* respectively, and not as different biological varieties of one species.

The *Phytophthora* diseases of *Hevea* in South India are caused by *P. Meadii*, a species which differs from *P. Faberi* in that it produces oospores in nature and in pure culture. Both the sporangia and the chlamydospores of *P. Meadii* are similar in shape and size to those of *P. Faberi*; in the absence of oospores, therefore, it is a difficult matter to distinguish the two species morphologically. The *Phytophthora* which causes similar diseases of *Hevea* in Burma has been identified by McRae (19) as *P. Meadii*, though in Burma it does not produce oospores.

It is thus evident that at least two species, with morphological characters similar to those of *P. Faberi*, are normally found on plants which are known to have been successfully inoculated with pure cultures of *P. Faberi*. As the Phytophthoras occurring on several different hosts in Ceylon have been referred to one species, viz. *P. Faberi*, it appeared advisable to make a comparative study of these strains to determine whether they are morphologically and physiologically identical. With that object in view, isolations were made of the Phytophthoras from diseased cacao pods, rubber pods, papaw fruit, papaw stem, breadfruit, *Dendrobium*, and *Odontadenia*, and the different strains grown in pure culture.

All cultures were started from single sporangia which had germinated as simple conidia. The sporangia were obtained either direct from the diseased tissues, or from cultures derived from diseased tissue. Dilution

plates were poured with bean agar, though maize-meal agar was generally used for tube cultures.

The cultures were grown in tubes at room temperature. The maximum and minimum temperatures recorded in the laboratory in which the cultures were grown, were 29°C and 22°C respectively. These temperatures were recorded during the hot season. Normally the temperature varied between 24°C and 27°C.

Growth on Culture Media

Maize-meal agar. All strains make good growth on maize-meal agar, and produce abundant, white, flocculent aerial mycelia. The development of aerial mycelium varies somewhat in different cultures, owing probably to differences in the hardness of the media and in the moisture content. In general, however, the aerial growth is greatest in cultures of the fungus from papaw stem.

Sporangia begin to be formed at the end of the second day. The strains from breadfruit, rubber, *Dendrobium*, and cacao produce sporangia more freely than do the strains from *Odontadenia* and papaw. In five-day old cultures of the former fungi, the mycelia have a powdery appearance, owing to the abundant development of sporangia, but in the latter cultures the sporangia are not so evident.

Chlamydospores are produced most abundantly in cultures of the cacao *Phytophthora*. In cultures of the breadfruit, rubber, *Dendrobium*, and *Odontadenia* strains, very few chlamydospores are produced in proportion to the number of sporangia, though some may be found in all cultures. In both the strains from papaw, sporangia and chlamydospores occur in almost equal proportions, and in this respect these strains resemble the cacao fungus.

The mycelia of all strains are similar, and typical of the genus *Phytophthora*. When young, the hyphae are non-septate and filled with dense granular protoplasm. In old cultures septation is more frequent. Transverse walls occur mainly to cut off the reproductive organs, and to separate empty sections of hyphae from those containing protoplasm. The aerial hyphae are more regular than the submerged hyphae, which have a somewhat warty or gnarled appearance. The diameter of the hyphae varies from 2-7 μ.

Bean agar. On this medium the growth is more submerged, and less aerial mycelia is produced. As on maize-meal agar, aerial mycelium is developed most abundantly by the strain from papaw stem, and to a lesser extent by that from papaw fruit. The strains from rubber, *Dendrobium*, breadfruit, and cacao give very little aerial growth, while that from *Odontadenia* is very variable ; in some cultures of the last the

aerial growth is as abundant as that of the papaw fruit strain, while in others very little is produced.

The submerged hyphae in bean agar have a more gnarled or tuberculate appearance than is common in cultures grown on maize-meal agar. Though the growth is good on this medium, it is not so rapid as that on maize-meal agar.

Spores are formed abundantly by the cacao, rubber, *Dendrobium*, and breadfruit strains on the surface of the agar, which consequently has a roughened or warted appearance. As on maize-meal agar, spore production is less in the *Odontadenia* strain and least in the two strains from papaw. Chlamydospores are not so freely produced by the cacao and papaw fungi as on maize-meal agar, and they are formed some few days after the sporangia have appeared. Few chlamydospores are to be found in cultures of the other strains on this medium.

Sporangiophores

The development of the sporangiophores may readily be observed in cultures grown on films of nutrient agar in Van Tieghem cells. The sporophores are not readily distinguished from ordinary hyphae except by the presence of sporangia. The sporangia are usually produced at the ends of the sporophores. The growth of a sporophore is, however, continued by a branch arising just below the previously-formed sporangium, and this in turn forms another at its tip. Continued sympodial branching results in the formation of numerous sporangia on what appears to be an unbranched sporophore.

The number of sporangia found on a single sporangiophore varies from 1 to 20. Some strains are more prolific of sporangia than others, the strains from rubber, breadfruit, and *Dendrobium* being the most productive, and those from papaw and *Odontadenia* the least. The latter fungi produce fewer sporangiophores. These facts would account for the comparative paucity of sporangia found in tube cultures of these strains.

The formation of lateral branches is rare in all strains. Usually the sporophores appear unbranched, and rarely are more than two branches to be found. Coleman's observations (9), however, indicate that the complexity of the sporangiophores of *P. Faberi* is very variable ; in some cultures the sporangiophores may be quite as complicated as those described for *P. omnivora*, though usually they are small and bear few sporangia. The complexity of the sporangiophores, therefore, must be used with the greatest caution for taxonomic purposes.

The length of the sporangiophores varies from 30-250 μ and the diameter from 2-5 μ in cultures grown in Van Tieghem cells on maize-meal

agar. In tube cultures the variation appears to be greater, but it is impossible to get accurate measurements owing to the tangled nature of the mycelium.

Usually the sporangiophores are regular and uniform, but in some cases they are inflated at various points into large or small swellings. Small swellings at the point of insertion of the sporangia are found frequently in cultures of the rubber and breadfruit Phytophthoras grown in Van Tieghem cells, but similarly swollen sporangiophores were rarely found in tube cultures. In some cases, the end of a hypha swells as though a sporangium were about to be formed; then the swelling ceases to increase, and three or four lateral branches are produced, which either form sporangia or continue as ordinary hyphae.

No distinctive characters of the sporangiophores were observed, by which the various strains could be readily separated from one another.

Sporangia.

The sporangia are normally produced on sporangiophores, but occasionally they are intercalary.

They are mostly pear-shaped, and attached to the sporangiophore at the blunt end. They may be narrowly or broadly ovate, or elliptical, and in some cases almost spherical. When grown on maize-meal agar, the sporangia of the cacao and papaw strains are, on the average, more broadly ovate than those of the other strains. In other respects the general appearance and structure of the sporangia of all the strains are alike.

At the apex, or narrow end, of the sporangium is a prominent raised papilla. Occasionally, sporangia with two papillae are seen, but these are obviously abnormal. The wall is thin, smooth, and colourless; the contents, finely granular, usually with a central vacuole. The wall at the base of the sporangium is usually thickened by a cellulose deposit on the inner surface. Frequently this deposit is represented only by a small plug or projection, situated immediately opposite the point of insertion. Old sporangia may have the whole of the inner surface of the sporangial wall covered by an even deposit of cellulose, resulting in a thickening of the wall similar to that common in chlamydospores. Occasionally the cellulose is deposited as small columns which project into the interior of the spore. Secondary thickening of the sporangium wall, other than a small deposit at the base in the shape of a small plug, is, however, rare, but some examples may be found in most old cultures. The presence of the cellulose plug is fairly constant, though in some sporangia it is better developed than in others, while in some it is entirely absent. Similar plugs have been reported by Butler and Kulkarni (6) for *P.*

Colocasiae, and by McRae (19) for *P. Faberi* and *P. Meadii*. According to McRae, the plugs are more frequently found in *P. Faberi* than in *P. Meadii*. The plugs found in these strains are, however, not usually so strongly developed as those figured for *P. Colocasiae*.

The sporangia usually fall off their sporangiophores with a short pedicel or vestige of the stalk attached. These pedicels rarely exceed 6 μ in length. The adhesion of a portion of the sporangiophore would not appear to be accidental, as the point at which abscission will occur may clearly be distinguished on many sporangiophores. Similar pedicels have been recorded by Butler and Kulkarni for *P. Colocasiae*, and observed by Zimmermann (34) in his *Phytophthora* from nutmeg.

Germination. Sporangia germinate either by zoospores or by germ tubes. No differences were observed between the various strains as to the size or number of zoospores formed in a sporangium nor in the mode of production of germ tubes.

Zoospores begin to emerge about 15 minutes after the sporangia are placed in water under suitable conditions. The number emitted from a single sporangium varies with its size ; the larger sporangia as a rule produce the greater number of swarm spores. The maximum seen to emerge was 26. The swarm spores are biciliate and vary in size from 7μ to 11μ. They swim about vigorously for some time, then come to rest, round themselves off and germinate by single germ tubes. If, as sometimes happens, the zoospores fail to escape from the sporangium, the germ tubes which originate from them penetrate the sporangium wall at various places and continue their normal growth. The germ tubes of those zoospores which come to rest near the dissolved papilla, usually emerge through that aperture.

When a sporangium germinates as a simple condium, it gives rise to one or more germ tubes. These may originate at any part of the sporangium wall, but when only one tube is produced, it usually arises from the base or side of the papilla. When germination occurs on a substratum rich in food material, the germ tubes continue their vegetative growth and give rise to a branched mycelium. In the absence of a plentiful food supply the germ tubes, after a short growth, form small sporangia at their tips. These secondary sporangia may germinate either by zoospores, or by germ tubes which in their turn may form tertiary sporangia. In old cultures such chains of sporangia may frequently be seen.

Environmental conditions determine to a large extent the method of germination. If a suspension of sporangia is made in fresh tap water, the water, after half an hour, will contain a large number of actively swimming zoospores. After two and a half hours no active zoospores will be present, though many mature sporangia have not germinated.

The majority of these germinate later as ordinary conidia. The proportion of sporangia which discharge their contents as swarm spores varies with the environmental conditions.

The main factors affecting the formation of zoospores are temperature, light, and air. The optimum temperature for the strains used in these investigations lies between 20° and 25°C; temperatures below 20° and above 25° retard zoospore formation. More sporangia discharge their contents when the suspension is well illuminated than when placed in the dark. Swarming, however, does occur in the absence of light, and it would appear that light is not as important a factor of zoospore formation in these strains as has been shown to be the case for *P. Arecae* (9) or *P. parasitica* (10).

The importance of a suitable air supply as a factor influencing the emission of zoospores has not generally been recognised. When measuring sporangia mounted in water, it was noticed that very few discharged zoospores, although conditions appeared to be suitable. When swarming was observed, it occurred from sporangia near the edge of the coverglass or in close proximity to air bubbles. This suggested the necessity of a requisite air supply. Subsequently, suspensions of sporangia were made in water which had been boiled and allowed to cool. Swarming, however, did not occur in such suspensions. Also, it was ascertained that in suspensions which are vigorously shaken in order to entrap air, more sporangia germinate by means of zoospores than in similar suspensions not shaken. The difficulty experienced by various investigators in obtaining zoospores at will, is possibly connected with the oxygen requirement of the species. In this connection, Klebahn's observations (14) on *P. Syringae* are of interest. Sporangia of this species were formed in water cultures, but they would not discharge zoospores unless they were placed in water well saturated with oxygen.

Chlamydospores

When working with *P. Faberi*, von Faber, Coleman and Rorer observed spherical bodies which they considered to be oospores. Neither von Faber nor Coleman observed antheridia, and von Faber failed to find oogonia also. Coleman explains the latter failure on the ground that the oospores "always fill the oogonial cavity so completely that the oogonial wall can be made out only with difficulty." Later writers have shown that these are multinucleate vegetative bodies serving the same function that chlamydospores serve in other groups of fungi. They are, therefore, not parthenogenetic oospores as stated by Coleman, but chlamydospores or "resting" conidia.

Chlamydospores were found in cultures of all strains on maize-meal

agar, and were more freely produced by the strains from cacao and papaw than by the others. Their formation depends to a large extent on external conditions, as it is well known that the production of chlamydospores is much greater on some media than on others. The absence of light, which is detrimental to sporangia development, favours the production of chlamydospores. Cultures of the strains from breadfruit, rubber and *Dendrobium*, which normally produce few chlamydospores, develop them more freely when grown in the dark.

The chlamydospores are formed either terminally or intercalarily in both the aerial and submerged mycelia. They are spherical, with smooth, thin or thick walls, and are filled with dense granular protoplasm. When first formed the walls are thin and colourless, but later they become thickened and sometimes yellow. In some cases, the wall becomes 3-4 μ thick owing to the deposit of cellulose on the inner surface, while in others the wall remains comparatively thin. Usually, the cellulose is evenly deposited, so that the inner surface of the wall remains smooth, but occasionally chlamydospores are found with small columns of cellulose projecting into the cavity of the spore.

The chlamydospores of *P. Faberi*, formed within the tissue of the cacao pod, usually have thicker walls and are more often coloured than those found in the surface mycelium. It would appear from Rorer's description that he designated the thick-walled form as oospores, and the thin-walled as chlamydospores. He states that chlamydospores "are formed much as are the conidia already described but are spherical." "Almost simultaneously with this superficial spore production oospores are formed within the tissues of the pod." He gives measurements of 30-50 μ for chlamydospores and 33-40 μ for oospores. The diameter of 200 chlamydospores with thin walls, obtained from the surface mycelium of the cacao strain grown on cacao pods, varied from 25-55 μ, the mean being 37.32±0.234 μ whereas thick-walled, yellow to yellow-brown spores from the tissue of the pod varied from 23-50 μ in diameter, the mean being 37.02 ±0.256 μ. There is, therefore, no real difference in size between the two forms. Owing to the structure of the spore wall, the thick-walled form might be mistaken for an oospore completely filling the oogonial cavity with the two walls in direct contact. There is little doubt, however, that the two forms are identical, except for the thickness of the wall, and that both are chlamydospores.

Germination. Though frequently termed "resting" conidia, chlamydospores do not require a period of rest before germination. When placed in water, they germinate readily within 48 hours, by means of one or more germ tubes which are frequently swollen at the base. These germ tubes give rise either to a richly branched mycelium, or to sporangia

resembling the secondary sporangia produced by germinating conidia. Secondary sporangia are more frequently formed when the chlamydospores are germinated in distilled water, than when a supply of food material is available for the developing mycelium.

Chlamydospores from dried-out cultures will not germinate, but spores from old,though still moist, cultures germinate readily. Moisture, therefore, appears essential for the retention of the vitality of these spores. It is, however, of interest that Rosenbaum(30) experienced considerable difficulty in inducing chlamydospores to germinate, and that he was successful only after wintering pure cultures.

Though germination is normally by germ tubes, it may also occur by means of swarm spores. In a few instances, swarm spores have been observed swimming vigorously within chlamydospores, though I have never seen them escape. That they do sometimes find their way out is evidenced by the presence of empty chlamydospores in old cultures. They appear to escape through a circular aperture in the spore wall, which is formed at a place where the wall has not been thickened. When the zoospores do not escape, they give rise to germ tubes, which penetrate the chlamydospore wall in the same way as the wall of an ordinary sporangium is penetrated by germ tubes arising from swarm spores which have germinated *in situ*.

From the literature on the subject, it would appear that zoospore formation in chlamydospores has rarely been observed, and that the normal germination is by germ tubes. Maublanc, (17) however, states concerning chlamydospores, " La germination se fait de facon analogue á celles des conidies," from which it would appear that, under certain conditions, zoospore formation may be the common method of germination.

Nature of chlamydospores. In some cultures, particularly those of the cacao strain grown in the dark, spherical bodies resembling chlamydospores are frequently observed. These bodies differ from the normal chlamydospores in having a prominent papilla, and in this respect they resemble sporangia. They represent what might be regarded as an intermediate stage between a sporangium and a chlamydospore. It is probable, therefore, that chlamydospores are modified sporangia. This view is supported, not only by the presence of intermediate bodies, but also by the fact that chlamydospores occasionally germinate by means of swarm spores. The formation of chlamydospores is in many respects similar to that of sporangia, though chlamydospores are rarely formed in "heads." Moreover, the wall of an ordinary sporangium is frequently thickened by a deposit of cellulose at the base, and in a few instances old sporangia have walls as thick as those of chlamydospores.

Chlamydospores may therefore be regarded as modified sporangia. The change in shape of the sporangium,from ovate to spherical, and the loss of the papilla, are accompanied by a change in function. Sporangia are always produced on the surface of the substratum and are well suited for dispersal during wet weather. They, however, cannot withstand dry conditions. Chlamydospores are generally produced within the substratum, though they are also to be found in the surface mycelium, and they are better adapted to withstand dry conditions. Thus they enable the fungus to tide over spells of adverse climatic conditions.

Measurement of Spores.

Owing to the paucity of distinguishing characters in many fungi. great importance has become attached to spore measurements for the delimitation of species. As the spores of any one species vary in size to some extent the dimensions are usually expressed by the limits of variation. This method, though convenient when the range of variation is small, is apt to be misleading when spore forms vary greatly in size. Since very large and very small values are infrequent, the observation of one exceptional individual may alter the range to a greater or lesser extent in either direction.

The spore measurements of *P. Faberi*, as given by various writers, are shown below.—

Authority	Sporangia	Chlamydospores
	μ	μ
von Faber	30-80 × 25-42	45
Rorer	30-60 × 21-30	30-50
Coleman	———	22-45
McRae	34-70 × 16-36	26-46 × 23-43 (average 35.3 × 35)
Maublanc (17)	30-65 × 20-53	30-60

These measurements, except where the average is stated, give no idea of the most prevalent size of the spore forms, which for purposes of comparison is of more value than the dimensions of the largest and smallest spores observed. Owing to the great variation in size of the spores, the limiting measurements are so widely separated, that it is possible that more than one species might be included within these limits, and yet remain indistinguishable by this method of recording spore measurements.

The use of more refined biometrical methods for defining spore dimensions would facilitate comparisons and assist in establishing morphological differences. Rosenbaum(30) has demonstrated the value of statistical methods as a means of delineating species of *Phytophthora*,

and his work suggested that similar methods would afford a ready means of differentiating between the various strains used in these investigations, should definite morphological differences occur.

If the measurements of a number of spores are classified according to their magnitude, it is a simple matter to construct a graph to represent their frequency distribution, and that will convey the general run of the observations to the eye better than a column of figures. In fig. 2, such curves have been constructed from the measurements of the diameters of 200 chlamydospores of each of the strains from rubber, papaw fruit and cacao. It is evident from these curves that the chlamydospores of the rubber strain are, in general, somewhat smaller than those of the strains from papaw fruit or cacao ; also, though the distributions of the papaw fruit and cacao strains centre round the same value (39 μ), they differ in their range of variation, the cacao strain being the more variable,

Though frequency curves tend to make long series comprehensible. and assist in making comparisons between different series of measurements, they are inconvenient for general purposes, as they enable only qualitative or verbal comparisons to be made. There are, however, three fundamental characters in which frequency distributions differ. They may differ in (1) position, (2) range of variation and (3) degree of asymmetry. Of these the first two are the most important. The use of measures which express these characters quantitatively affords a convenient method of defining the size and degree of variation of spore forms. They also enable comparisons between different series of measurements to be made readily.

The mean, together with its probable error, has been used in these investigations as the basis for comparison of spore measurements of the different strains. In the comparison of two statistical results, the difference between the two results, compared with its probable error, is of great importance. If the difference is more than five times greater than its probable error, it may justifiably be considered as significant of a real difference existing between the two results, as the probability of its having arisen as a result of random sampling is small. This standard has been used throughout to determine the significance of observed differences, differences less than five times as great as their probable errors being attributed to errors of sampling.

Statistical methods have been used not only to express the actual measurements of length and width of sporangia, but also to give some quantitative expression of their shape. The ratio of the length to the width of a sporangium expresses quantitatively what is usually stated

qualitatively by the terms elliptical, ovate and globose. If the ratio of the long and short diameters of each sporangium measured is determined, the mean of these determinations becomes a fair measure of the shape of the sporangium. By the use of such methods, the shapes of sporangia may be compared as readily as their dimensions.

Method of measurement.—At first, spore measurements were made to the nearest micron by means of 1.8 mm. oil immersion objective and an eyepiece micrometer. The risk of measuring the same spores twice was avoided by the systematic use of a travelling stage. The measurements so made were then grouped into 2 μ classes to facilitate the calculation of the mean and standard deviation. It was found, however, that when the calculations were based on a grouping in which the classes differed by 4 μ instead of 2 μ intervals, the results were but slightly affected. This may be seen from Table 1, in which are given biometric constants calculated from two sets of measurements, each of which were grouped into 2 μ and 4 μ classes. Measurements A refer to 200 sporangia of the cacao fungus grown on cacao pod; measurements B are of a similar number of sporangia of the same fungus cultured on rubber pods.

Table 1.

The effect on the calculated mean, median, etc., of grouping measurements into classes with 2 μ and 4 μ intervals.

Measurements	Class interval.	Mean μ	Median μ	Mode μ	Standard deviation. μ	Skewness
Length of Conidia						
A	2 μ	45.52±.384	45.71	46.09	8.05±.271	—.071±.058
A.	4 μ	45.54±.388	45.77	46.23	8.14±.274	—.085±.058
Difference		.02±.546	0.6	.14	.09±.385	.014±.082
B	2 μ	42.10±.284	42.04	41.92	5.97±.201	.030±.058
B	4 μ	42.14±.287	42.20	42.32	6.02±.203	—.030±.058
Difference		.04±.378	.16	.40	.05±.286	.06±.082
Width of Conidia						
A	2 μ	27.62±.112	27.49	27.23	2.35±.079	.166±.058
A	4 μ	27.60±.107	27.61	27.63	2.34±.079	.013±.058
Difference		.02±.115	.12	.40	.01±.112	.153±.082
B	2 μ	25.52±.142	25.41	25.19	2.99±.101	.110±.058
B	4 μ	25.42±.151	25.38	25.30	3.17±.107	.038±.058
Difference		.10±.210	.03	.11	.18±.147	.072±.082

The effect of the grouping on the resulting calculations is evidently very small, as is shown by the size of the differences, in comparison with their probable errors. It would, therefore, appear immaterial whether the grouping is made by 2 μ or by 4 μ classes. Where the measurements are grouped into classes, all measurements ranging between the limits of a class are considered to be of equal value, that value being represented by the mid-point of the class. For instance, where the grouping is by 4 μ classes, all measurements ranging between 37.50 μ and 41.49 μ are considered to be equal, their value being 39.5μ. the mid-point of the class. If, therefore, a sporangium, 38 μ long, may be regarded as equal in length to others which measure 39, 40, or 41 μ, without seriously affecting the resulting calculations, it is improbable that slight errors in measurement are of great importance, so long as they do not all occur in the same direction.

The measurement of a large number of sporangia by means of an oil immersion lens is a slow and tedious business. As these investigations necessitated the measurement of numerous spores, it appeared advisable to determine whether the use of a lower power objective, and the consequent decreased accuracy of measurement, would vitiate the value of the constants calculated from measurements so made. A test was made by measuring sporangia of the *Dendrobium* strain grown on maize-meal agar, first by means of a 4 mm. objective (one square of the eyepiece micrometer representing 16 μ) and then with a 1.8 mm. oil immersion lens (one square of the eyepiece micrometer representing 6 μ). Altogether 131 sporangia were thus measured. The constants calculated from each set of measurements are given in Table 2 for comparison. For these calculations, the measurements of length and width were grouped into 2 μ classes.

Table 2.

Comparison of constants calculated from measurements made by means of objectives of different magnification.

Length of Conidia.

Objective.	Mean.	Median	Mode	Standard deviation.	Skewness
	μ	μ	μ	μ	
1.8mm.	51.69±.508	51.28	50.46	8.62±.359	.143±.072
4mm.	51.67±.506	51.50	50.86	8.58±.349	.092±.072
Difference	.02±.717	.22	.40	.04±.501	.051±.10

Width.

Objective.	Mean. μ	Median. μ	Mode. μ	Standard deviation. μ	Skewness.
1.8 mm.	28.74±.204	28.61	28.35	3.47±.145	.112±.072
4 mm.	28.57±.210	28.42	28.12	3.56±.148	.126±.072
Difference	.17±.293	.19	.23	.09±.207	.014±.102

Ratio of length to width.

1.8 mm.	1.82±.017	1.83	1.85	.295±.012	—.102±.072
4 mm.	1.82±.018	1.82	1.82	.301±.013	.000±.072
Difference	0.±.025	.01	.03	.006±.018	.102±.102

It will be seen that the differences between the constants, calculated from the measurements made with the different objectives, are so small as to be negligible for practical purposes. Measurements made with the aid of a 4 mm. objective are undoubtedly more liable to error than those obtained with a more powerful oil immersion objective. The errors resulting from the use of an objective of lower power, however, tend to neutralise or offset each other, as, where a large number of spores are measured, it is probable that as many measurements are too large as are too small. For this reason, the greater errors in measurement resulting from the use of a lower powered objective do not appreciably disturb the mean and other constants.

Tests were also carried out to determine whether 200 spores constituted a representative sample of the population from which they were taken. Two separate samples, each of 200 sporangia, were measured on the same day from the same culture ; the constants were then calculated for each sample and compared. In Table 3 the constants obtained from two such samples of sporangia of the rubber *Phytophthora*, grown on rubber pods, are given for comparison. The measurements were made by means of the 4 mm. objective and were grouped into 2 μ classes.

Table 3.

Measurements of two samples, each of 200 conidia, taken from the same culture.

Length.

Sample	Mean.	Median	Mode	Standard deviation.	Skewness.
	μ	μ	μ	μ	
A	39.55±.332	38.96	37.78	6.97±.235	—.254±.058
B.	39.61±.368	39.02	37.84	7.70±.259	—.230±.058
Difference	.06±.496	.06	.06	.73±.350	.024±.082

Width.

A	24.01±.127	38.80	23.38	2.66±.090	—.237±.058
B.	24.52±.139	24.20	23.56	2.91±.098	—.330±.058
Difference	.51±.187	.40	.18	.25±.133	.093±.082

Ratio, length to width.

A.	1.65±.010	1.61	1.53	.219±.074	—.552±.058
B.	1.62±.011	1.61	1.59	.239±.081	—.125±.058
Difference	.03±.015	0	.06	.02±.110	.427±.082

These tests indicate that 200 sporangia constitute a representative sample of the population from which they are taken. This was adopted as the normal size of a sample, and all biometric measures given here, unless otherwise stated, are based on the measurements obtained from 200 spores. The measurements were made by means of a 4 mm. objective and an eyepiece micrometer, and were grouped into 2 μ classes to facilitate calculations.

Effect of environment on spore dimensions.

During the progress of these investigations, it became evident that the mean measurements of the spore-forms of a strain are not constant, but vary according to the conditions under which the cultures are

grown. Very rarely are identical measurements obtained from different cultures of any strain, even when grown on the same medium, if the environmental conditions are varied.

The age of a culture at the time sporangia are measured is of primary importance. With the increasing age of a culture various abnormalities, particularly secondary sporangia, become more prevalent. As secondary sporangia are usually smaller than the primary sporangia from which they are derived, any increase in the proportion of secondary sporangia results in a corresponding diminution of the mean measurements. Consequently measurements of sporangia made from old cultures are, on the average, smaller than those from young cultures. Measurements of sporangia are therefore best made at the time when they first make their appearance and before secondary sporangia are formed.

When chlamydospores are measured, the age of the culture is not so important, as there is no marked increase or diminution of their mean diameter with increasing age. The mean diameter obtained from measurements of a culture three months old is approximately the same as that of a young culture with fully developed chlamydospores.

It is well known that species of *Phytophthora* produce different spore forms on different media. On sterilised potato, *P. Faberi* produces chlamydospores in abundance and very few sporangia ; on bean agar, sporangia predominate and chlamydospores are rare. As the nature of the substratum exerts a large influence on the type of spore produced, it may be expected that it will influence the size of the spores also. It may be seen from Table 1 that the measurements of sporangia of the same strain, when grown on cacao pods (A) are greater than those obtained when the fungus is grown on rubber pods (B). The size of the chlamydospores is also influenced by the medium on which they are grown ; e.g., the strain from rubber produces somewhat larger chlamydospores when cultured on cacao pods than when grown on rubber pods. Though none of these strains produces oospores in pure culture, it is of interest to note that the size of these bodies may also be influenced by the substratum. Dastur (12) records that *P. parasitica* from *Vinca rosea* produces smaller oospores on French-bean agar than on oat juice agar.

Small differences, however, occur when measurements are made from cultures growing on apparently similar substrata. Below are given mean measurements of sporangia of the rubber strain, obtained from different cultures grown on maize-meal agar

	Length.	Width	Ratio L/W.
	μ	μ	
(1)	49.37±.390	28.82±.180	1.72±.013
(2)	54.99±.400	30.57±.213	1.80±.013
(3)	47.92±.315	26.45±.162	1.79±.009

These differences may be due to small changes in the chemical constituents, or to varying amounts of moisture in the media. Such differences occur not only with cultures grown on artificial media, but also on natural substrata, as may be seen from the following measurements of sporangia of the rubber strain obtained from different cultures on *Hevea* pods.

	Length	Width.	Ratio L/W
	μ	μ	
(1)	39.55±.332	24.01±.127	1.65±.010
(2)	47.40±.369	27.06±.149	1.76±.011
(3)	44.17±.277	27.30±.116	1.62±.009

Moisture is an essential factor for the formation of sporangia; and from the fact that sporangia produced in tube cultures are frequently larger than those formed in cultures in petri dishes, it would appear that moisture may be an important factor influencing the size of sporangia. The size of chlamydospores, however, is not appreciably affected by varying amounts of moisture.

When grown in the dark, cultures of all the strains under investigation produce very few sporangia on maize-meal agar, but these are, on the average, larger than those produced in cultures grown on the same substratum in the light. The effect of light on the size of sporangia is shown by the following measurements, made from cultures of the rubber strain, grown on maize-meal agar in tubes.

	Mean length.	Mean Width.	Mean ratio L/W
	μ	μ	
In light	47.98±.357	25.42±.153	1.89±.013
In darkness	51.92±.366	27.89±.172	1.87±.013
Difference	3.94±.511	2.47±.230	.02±.018

The tubes were poured from the same stock, and inoculated from the same culture, but one was placed near the window and the other enclosed in a light-tight box near by. The measurements were made when the cultures were four days old. These measurements show that, though the sporangia of the two cultures differ in length and width, yet their shape remains constant.

The size of the chlamydospores is similarly affected by light. The mean diameter of 200 chlamydospores of the cacao fungus, grown on maize-meal agar in the light, was found to be $39.64 \pm .240$ μ, whereas that of the chlamydospores of a similar culture grown in the dark was $43.72 \pm .278$ μ, the difference being $4.08 \pm .367$ μ. This is a significant difference, from which it may be concluded that light influences the size of chlamydospores in the same way as it affects the dimensions of sporangia.

Concerning the effect of temperature, Rosenbaum states that low temperatures tend to diminish the size of spore forms, and higher temperatures to diminish their production. Experiments were not carried out with controlled temperatures during these investigations, but it would appear from a comparison of measurements made from cultures grown at room temperature at various times, that the effect of temperature on the size of the spore forms is not at all marked within the normal range of temperature of the laboratory at Peradeniya.

Owing to the influence of environmental conditions on spore dimensions, measurements must be made from cultures growing under identical conditions if they are to be strictly comparable. Unless the external conditions are very similar, conclusions based on differences between spore measurements of species of *Phytophthora* are likely to be vitiated by the variability of the spore dimensions resulting from the effects of the different conditions.

The value of spore measurements, as a means of delineating species of *Phytophthora*, is considerably diminished owing to the variability of the size of the spores when grown under different environmental conditions. The mean measurements of the spores of any one species are not necessarily the same wherever that species is found, even when it occurs on the same host plant, as any difference in climatic conditions may appreciably affect the dimensions of the spores. Also, where a species attacks more than one host, the spores obtained from one host may differ appreciably in size from those obtained from another, owing to the effect of the different substrata.

Measurements of Sporangia.

In order to obtain comparable measurements of sporangia of the different strains, cultures of each were grown in petri dishes on maize-meal agar. The plates were poured from a common stock, and stood side by side in the laboratory, the temperature of which varied between 23° and 27°C during the period these cultures were under observation. Measurements of the breadfruit, cacao, rubber and *Dendrobium* strains were completed within the first five days, but those of the papaw and *Odontadenia* strains were not completed till the seventh day, as they were

later in producing sporangia. The mean measurements of 200 sporangia from each strain are given in Table 4.

Table 4.

Comparable measurements of sporangia from maize-meal agar cultures.

Strain	Mean length μ	Mean width. μ	Mean ratio L/W
Cacao	48.17±.297	34.09±.231	1.42±.006
Papaw fruit	49.84±.336	32.56±.269	1.55±.010
Papaw stem	48.41±.394	32.37±.267	1.56±.011
Rubber	47.92±.315	26.45±.162	1.79±.009
Odontadenia	48.58±.447	26.46±.195	1.84±.011
Dendrobium	49.50±.376	26.53±.123	1.86±.010
Breadfruit	49.59±.310	27.38±.253	1.80±.007

In length the sporangia are alike ; the observed differences between the various strains are not sufficiently marked to warrant the conclusion that they are real, or due to causes other than errors in sampling. As regards their width, however, the strains fall into two distinct groups ; the cacao and papaw strains, having wider sporangia, constitute one group, and the remaining strains the other. The differences in width give rise to differences in the ratios of length to width, by which shape is denoted. There is a significant difference between the length to width ratio of the cacao strain and that of the papaw fruit strain, but the separation of the cacao from the papaw strains is not warranted by other measurements made from cultures on maize-meal agar. On this medium, the sporangia of the rubber, *Odontadenia*, *Dendrobium* and breadfruit strains are consistently more elongate than those of the cacao and papaw strains.

The strains may, therefore, be divided into two distinct groups according to the shape of their sporangia. The cacao and papaw strains are alike in having, on the average, broadly ovate sporangia, and these strains for convenience will be referred to as the cacao group. The other strains with more elongate sporangia constitute a second group, which may be termed the rubber group

In fig. 1, the frequency distributions of the mean length to width ratios of the papaw fruit and the rubber strains respectively are represented graphically. The frequency distribution for the papaw stem strain is very similar to that of the strain from papaw fruit, but that for the cacao strain is somewhat less dispersed, as may be judged from the probable error of the mean, though the two curves centre about the same

point. The frequency distributions of the *Dendrobium*, *Odontadenia* and breadfruit strains are very similar to that of the rubber strain. The curves given in fig. 1 may therefore be taken as typical of the two groups.

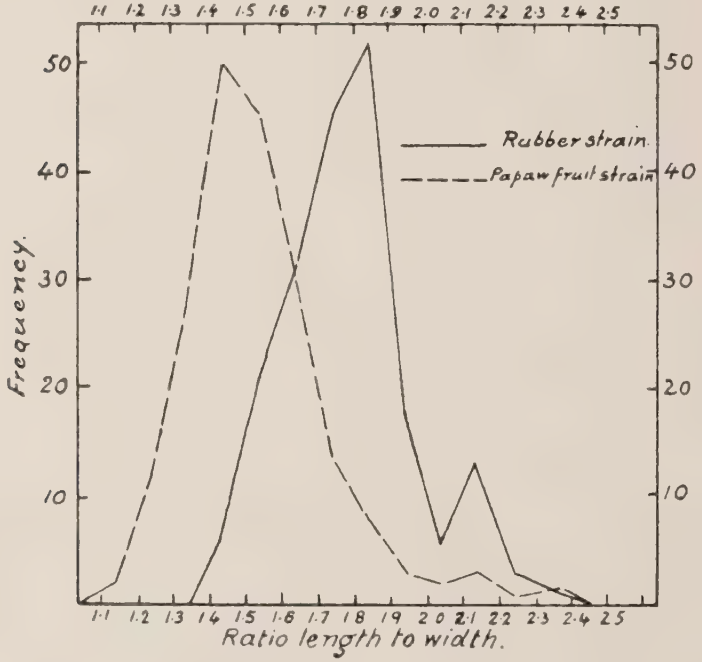

Fig. 1. Frequency distribution of the ratio, length to width of sporangia of the strains from papaw fruit and rubber.

This difference in shape of the sporangia between the two groups, however, is not constant on all media. Measurements made on the rubber and cacao strains grown on rubber pods give mean length to width ratios of 1.65 and 1.62 respectively, the shape thus being practically the same. Again, from measurements made of sporangia on the *Dendrobium* material from which the strain was isolated, a mean ratio of 1.36 was obtained, as against 1.86 on maize-meal agar. Evidently the mean shape of sporangia is influenced to a great extent by the nature of the substratum.

If, for reasons already adduced, chlamydospores are regarded as modified sporangia, it is to be expected that some conditions, such as the nature of the substratum, which favour the production of chlamydospores to the detriment of sporangia, will have some influence on the shape of the sporangia, tending to make them more globose. In this respect it is of interest that the three strains with broadly-ovate sporangia, which form the cacao group, produce chlamydospores more readily on maize-meal agar than do those strains with narrow ovate sporangia, which form the rubber group.

Chlamydospores.

The cultures from which the measurements of chlamydospores, given in Table 5, were obtained, were grown on maize-meal agar in tubes poured from the same stock and placed side by side in the laboratory. The measurements were made during the third week. During this period the room temperature varied from 22° to 26°C.

Table 5.

Comparable measurements of chlamydospores from maize-meal agar cultures.

Strain	Mean μ	Median μ	Mode μ	Standard deviation μ
Cacao	39.63±.317	39.32	38.50	6.64±.224
Papaw fruit	38.89±.190	38.97	39.13	3.98±.134
Papaw stem	38.79±.199	38.97	39.33	4.13±.139
Rubber	35.46±.216	35.71	36.25	4.52±.152
Odontadenia	36.02±.174	36.35	36.65	3.65±.123
Dendrobium	35.11±.254	35.34	35.80	5.33±.179
Breadfruit	35.32±.185	35.39	35.53	3.88±.131

It will be seen, from the mean measurements of the diameter of the chlamydospores, that the strains may again be divided into two groups. The cacao and papaw strains again form one group, and the remaining strains the other. This grouping is identical with that arrived at from measurements of the sporangia.

The chlamydospores of the cacao group are larger than those of the rubber group, the former having a mean diameter of approximately 39 μ, and the latter a mean of 35.5 μ approx. The frequency distributions of the cacao, papaw fruit, and rubber strains are represented graphically in Fig. 2. The curve for the rubber strain is similar to those of the other members of its group, and may be taken to represent the group. The frequency curve for the strain from papaw stem is identical with that

given of the papaw fruit strain. It will be seen, however, that though the curve representing the frequency distribution of the cacao strain, centres about the same point as does that of the papaw fruit strain, it is flatter, covers a greater range, and is more dispersed. Though the cacao strain may be distinguished from the papaw strains by the greater variability of the chlamydospores on maize-meal agar, such a differentiation would serve little purpose, and the three strains may, at least for the present, be regarded as forming one group.

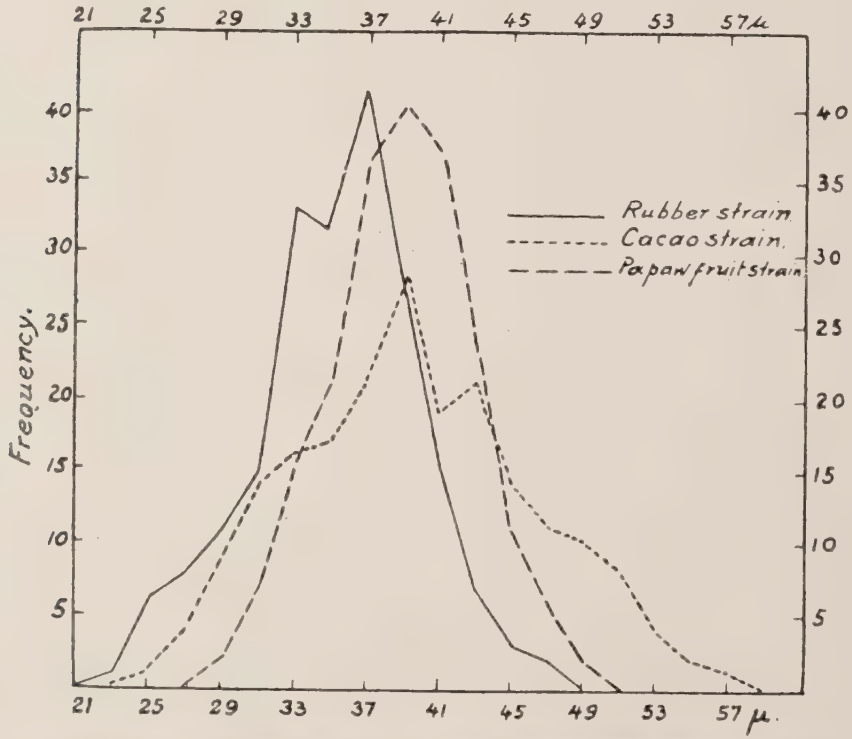

Fig. 2. Frequency distribution of chlamydospore measurements of the strains from cacao, papaw fruit and rubber.

Though the chlamydospores of the cacao group may be distinguished from those of the rubber group, when grown on maize-meal agar, by their greater size, this difference is not constant on other media. On cacao pods, the mean diameter of the chlamydospores of the cacao strain was found

to be 37.02±.256 μ, and that of the rubber strain 37.91±.240 μ. On *Hevea* pods, the mean diameters of these strains are approximately equal, but smaller than those obtained from cultures growing on cacao pods.

It will be evident from the foregoing, that the morphological differences between the cacao and rubber groups, as exhibited by measurements of the spore forms on maize-meal agar, are lost when the cultures are grown on certain other media. Consequently the value of these characters as a means of distinguishing the groups is correspondingly diminished.

Oospores.

Oospores were not found in any of the pure cultures, nor in the tissues of the host plants from which the strains were isolated. They were found, however, when certain strains were grown in mixed culture. Mixed cultures, obtained by inoculating maize-meal agar slants with the strains from cacao and *Odontadenia* an inch or so apart, produce sexual bodies abundantly, at first at the line of junction of the two colonies, and later in the zones of both the cacao and the *Odontadenia* fungi.

These sexual bodies are of the *P. infestans* type with persistent amphigynous antheridia.

The oogonia are spherical, with thick, yellow or yellow-brown walls, and vary from 28 to 34 μ in diamater. At times the thick wall is so opaque that it is only with difficulty that the enclosed oospore can be seen. At first the wall is thin and smooth, and has a definite sharp outline, but later, owing to a deposit of secondary thickening, the outer surface of the wall becomes rough and loses its sharp definition. The wall may become as much as 4 μ thick. As a rule, the largest oogonia have the thickest walls as an increase in thickness of the wall results in an increase in diameter of the oogonium. The thickness of the wall, and consequently the diameter of the oogonium itself, depends to some extent on the nature of the substratum. On bean agar the oogonium wall is never so strongly thickened as on maize-meal agar, nor is the smooth distinct outline lost.

The oospores are spherical, smooth and hyaline. They vary in diameter from 21 to 28 μ, and the wall varies from 1 to 2 μ in thickness. The oospore never completely fills the cavity of the oogonium, nor is it ever liberated from the oogonium. Thus the oogonial wall forms an extra, permanent coat for the spore.

The antheridia are hyaline, thin-walled, and remain firmly attached to the base of the oogonium. They vary in length from 10 to 16 μ, and in width from 13 to 17 μ. Usually, the antheridia are empty after the oospores are developed, though they may sometimes contain one or more globules.

As far as could be ascertained, the oogonia and antheridia are always formed on separate hyphae. In many cases, however, it is impossible to trace the hyphae back to their point of origin ; usually they can be traced only a short distance from the sexual bodies. Frequently it is impossible to determine the origin of the sexual organs, particularly when they are produced around a stromatoid body.

The oospores are, as a rule, embedded in the medium, and are often found upon, or in close proximity to, stromatoid bodies. The stromatoid bodies are formed by a process of budding, which, when continued, forms a compact mass with apparently cellular structure, such as is figured on Plate X. These bodies vary in size up to 500 × 350 μ, and when well grown are usually covered by numerous, almost sessile, sexual bodies. The presence of stromatoid bodies is not absolutely constant, nor is the production of oospores dependent on their presence. In some mixed cultures, sexual spores may be found in abundance in parts of the medium in which there are no stromatoid bodies, while in other cultures oospores are not found except in clusters around these bodies. They were found, however, in all oospore-producing cultures on maize-meal agar.

Similar bodies appear to have been found by Dastur (10) in cultures of *P. parasitica*. He states " The oospores in oat-juice agar are embedded in the medium and are as a rule confined to those portions containing matted budding hyphae, which are considered to store reserve material for the fungus. They are invariably empty after the formation of oospores. Very often the oospore is completely entangled in the net work of those hyphae." The stromatoid bodies found in the mixed cultures differ from those described for *P. parasitica*, in that the cells of the former are not empty after the development of the oospores. Moreover, the oospores are produced on the bodies found in the mixed cultures, and not entangled in the net-work as in *P. parasitica*.

Oospores of *P. parasitica* were obtained by Dastur in cultures grown on French-bean-juice agar as well as upon oat-juice agar. It may be inferred from the above-quoted statement that the tangled networks of budded hyphae were not found in the French-bean-juice agar, as only oat-juice agar cultures are mentioned in this connection. It would appear probable, therefore, that the formation of these bodies is to a large extent influenced by the nature of the substratum.

The seven strains under investigation were grown in pairs in mixed culture in tubes on maize-meal agar slants at room temperature. Two cultures were made of each combination of strains ; these differed only as regards the position of the points of inoculation. The strain which was placed near the bottom of the slant in one culture, was placed near the top of the other, and *vice versa*. The room temperature varied from 22° to 29°C during the 5 months these cultures were under observation.

The mixed cultures in which oospores were found are enumerated in Table 6, in which are also shown the range of variation and the mean diameter of the oospores measured.

Table 6.

Measurements of oospores from mixed cultures.

Strains in mixed Cultures	Medium	No. of oospores measured.	Range of variation μ	Mean diameter μ
Cacao and *Odontadenia*	Bean agar	25	19—25	22.12±.210
Cacao and *Odontadenia*	Maize-meal agar	50	21—28	23.78± 148
Cacao and Rubber	do.	35	20—28	23.66±.193
Cacao and *Dendrobium*	do.	25	21—26	23.56±.175
Cacao and Breadfruit	do.	50	22—27	23.96±.122
Papaw fru t and *Odontadenia*	do.	30	17—28	23.43±.278
Papaw fruit and Rubber	do.	1	22	——
Papaw stem and *Odontadenia*	do.	30	19—29	23.07±.229
Papaw stem and Rubber	do.	14	19—25	22,36±.341
Papaw stem and Breadfruit	do.	2	22—23	22.50

The mean measurements of the oospores from the various mixed cultures, grown on maize-meal agar, are fairly constant. The mean

measurement from the mixed culture of the papaw stem and rubber strains is the smallest, but it does not differ significantly from the largest, which was obtained from the mixed culture of the cacao and breadfruit strains. Consequently, the oospores of the various mixed cultures cannot be differentiated by their size. In form also they are alike, and it would appear probable that we are dealing with the same oospore throughout.

The sexual bodies here described agree very closely with the description given by Ashby(3) of the sexual bodies found in mixed cultures of the Phytophthoras from cacao and coconut, grown by him on slants of French-bean agar. He obtained similar oospores when *P. Faberi* was grown in mixed culture with a strain of *Phytophthora* from cotton bolls, or with *P. parasitica*. His observations show that the oospores formed are actually those of *P. Faberi*.

Ashby, however, makes no mention of the presence of stromatoid bodies in his cultures. This, as already indicated, may be due to the fact that the formation of these bodies is influenced by the substratum on which the fungi are grown, and that French-bean agar does not favour their development.

The mean size of the oospores found in Ashby's cultures was 23.3 μ, with a variation from 19-26.5 μ. These measurements agree fairly closely with the measurements given in Table 6. As the latter measurements were made from cultures on maize-meal agar, a further series of cultures was made on French-bean agar, in order to ascertain whether the size of the oospores was constant for both media. The oospores were not produced so freely on French-bean agar as on maize-meal agar; consequently measurements were made of only 25 oospores of the mixed culture of the cacao and *Odontadenia* strains. The mean of these measurements is 22.12 ±.210 μ, which is slightly smaller than that (23.78 ±.148 μ) obtained from cultures grown on maize-meal agar. The number of spores measured is, however, too small to base any definite conclusion on these measurements. From the fact that the measurement from the culture on French-bean agar is very close to that obtained from the mixed culture of the Papaw stem and rubber strains on maize-meal agar, it would appear that the differences observed between the measurements from the different media are probably due to fluctuations in sampling, rather than that the medium has any definite influence on the size of the oospore.

The mean diameter of oogonia from cultures on French-bean agar is, however, definitely smaller than that obtained from cultures on maize-meal agar. On French-bean agar the mean was found to be 25.6 μ, and on maize-meal agar, 30.1 μ. This is due mainly to the much greater thickening of the oogonial wall on the latter medium.

No stromatoid bodies were observed in the French-bean agar cultures, so that it would appear that the formation of these bodies is influenced by the medium. It must, however, be stated that these cultures were not so thoroughly searched as were those on maize-meal agar.

The variability and uncertainty in the production of oospores of certain species of *Phytophthora* are well known ; some portions of a culture medium may contain numerous sexual bodies, while other portions for no apparent reason may contain none. Such variation was found to occur in the mixed cultures.

Mixed cultures of the cacao and *Odontadenia* strains produce oospores freely, and owing to their abundant production there is little difficulty in finding them. They are first produced in the zone at the junction of the two strains, but later they are to be found in the zones occupied by both the cacao and the *Odontadenia* strains. In other mixed cultures, e.g. those of the cacao and *Dendrobium* strains, very few oospores are produced, and these usually occur in clumps at the junction of the two strains. In the mixed cultures of the papaw fruit and rubber strains, and of the papaw stem and breadfruit strains, only one and two oospores respectively were found, although the cultures were very thoroughly searched.

From the variability of the number of oospores found in mixed cultures, it would appear that the potentiality of the various strains for the production of sexual bodies differs. Of the strains which form oospores when grown in mixed culture with the cacao strain, the strain from *Odontadenia* is the most efficient, and that from *Dendrobium* the least. The strain from *Odontadenia* also forms oospores when grown in mixed culture with either of the papaw strains, whereas that from *Dendrobium* does not produce oospores with either.

Table 7.

Oospores in mixed cultures.

Strain from	Strain from: Cacao	Papaw fruit.	Papaw Stem.	Rubber	*Dendrobium*	*Odontadenia.*	Breadfruit.
Cacao	—	O	O	X	X	X	X
Papaw fruit	O	—	O	X	O	X	O
Papaw Stem	O	O	—	X	O	X	X
Rubber ..	X	X	X	—	O	O	O
Dendrobium	X	O	O	O	—	O	O
Odontadenia	X	X	X	O	O	—	O
Breadfruit	X	O	X	O	O	O	—

In Table 7, the mixed cultures in which oospores are developed are represented by X ; the absence of oospores is indicated by O. It will be seen from this table, that oospores are produced only in mixed cultures which contain either the cacao strain or one of the papaw strains. When, however, the cacao strain is grown with one of the papaw strains, and when the two papaw strains are grown together, no oospores are formed. Also when any one of the strains from *Odontadenia*, rubber, *Dendrobium*, or breadfruit is grown in mixed culture with any other, no oospores are formed ; whereas oospores are developed when any one of them is grown in mixed culture with the cacao strain. It is therefore possible to divide the strains into two groups,—the cacao group consisting of the cacao and papaw strains, and the rubber group consisting of the strains from rubber, *Odontadenia*, *Dendrobium*, and breadfruit.

Two strains from one of these groups, when grown in mixed culture, will not form oospores, and it is only by growing a strain from the cacao group with one from the rubber group that oospores are obtained. It should be noticed that the grouping of the strains corresponds with the classification based on the shape of the sporangia and on the size of the chlamydospores.

The above observations would admit of interpretation upon the assumption of heterothallism, though the possibility of hybridism is not precluded. The facts that *P. Faberi* produces oospores when crossed with *P. parasitica*, and that sexual bodies have been obtained by growing *P. infestans* in mixed culture with *P. Phaseoli*, (8), indicate the possibility of hybridism. Owing to the similarity of the strains in pure culture, however, the assumption of heterothallism would appear more probable. Unfortunately, attempts to germinate the oospores have been unsuccessful.

Inoculation Experiments

Inoculation experiments were carried out on fruits of cacao, papaw, *Hevea*, and breadfruit. The fruits were first washed with corrosive sublimate solution and then with sterile water. They were placed in glass dishes, containing a little distilled water in order to provide a damp atmosphere. Only one fruit of the cacao, papaw, or breadfruit was placed in a dish, but as many as four *Hevea* fruits were put together in one dish. In the latter case all the fruits were inoculated with the same strain. All fruits were healthy, well grown though not quite ripe, and were obtained as far as possible from trees not affected by disease. The *Hevea* pods, breadfruit, and papaw fruits were obtained from trees which were

known not to be attacked by *Phytophthora* fruit diseases. Cacao pod rot, however, is so general that cacao pods had to be used from an estate on which the *Phytophthora* was known to be prevalent.

Controls were used in all the experiments. Only one control fruit, and that a cacao pod, gave a positive result. Inoculations were counted as successful only when the disease originated at the point of inoculation. In nature, cacao pods are usually infected at the stalk end or at the tip. Inoculations were therefore made on the sides of cacao pods in order to avoid the possibility of a previous natural infection at the point of inoculation.

The inoculations were made by transferring, from pure cultures, small pieces of mycelium bearing ripe sporangia into water placed on the fruit. Wax rings were placed on the fruits to prevent the water running off. When the inoculation was made through a wound, the wound was made by cross hatching the surface of the fruit with a sharp sterile knife or with a sterile needle.

Cacao fruits. Six inoculations were made with each strain on unwounded cacao fruits. The pods inoculated with the cacao strain showed a discoloration at the points of inoculation after 3 days, and sporangia appeared on the surface in 5 or 6 days. The discoloration rapidly extended over the whole fruit, and was followed by a rich growth of mycelium. Inoculations with other strains on unwounded pods were not successful.

On wounded fruits, all strains gave positive results ; but the discoloration was much later in making its appearance, and the growth of the fungus was not so good, when inoculations were made with other strains, as when they were made with the cacao strain. In some cases no discoloration occurred until the third week from inoculation ; but when established the fungus grew rapidly until, by the end of the fourth week, the pods were entirely discoloured and sporangia and chlamydospores were found in abundance in the aerial mycelium covering the pod. The period elapsing between the times of making the inoculation and the appearance of a discoloration around the point of inoculation, was not constant for any one strain. Of 5 inoculations made on wounded cacao with the strain from papaw stem, two became discoloured in 3 days, and sporangia were present on the 5th day ; two showed no sign of successful inoculation till the 21st day, and one failed entirely. Similar results were obtained with other strains, except the one from cacao which always infected cacao pods readily.

Table 8.

Cross inoculation experiments.

Fruits Inoculated	Inoculations with strain from																	
	Cacao		Papaw fruit.		Papaw Stem.		Rubber		*Dendrobium.*		*Odontadenia.*		Breadfruit.	
	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.	I.	S.
Cacao														
Unwounded	6	6	6	0	6	0	6	0	6	0	6	0	6	0
Wounded	5	5	5	2	5	4	5	5	5	4	5	3	5	2
Papaw														
Unwounded	3	1	3	3	3	3	3	2	3	0	3	1	3	0
Wounded	4	4	4	4	4	4	4	3	4	4	4	2	4	4
Hevea														
Unwounded	12	9	12	8	12	8	12	12	12	11	12	9	12	8
Wounded	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Breadfruit														
Unwounded	4	0	4	2	4	2	4	0	4	2	4	3	4	4
Wounded	2	0	—	—	—	—	2	2	—	—	—	—	—	—

I.=inoculations. S.=successes.

Papaw fruits. Three inoculations were made with each strain on unwounded papaw fruits. The inoculations made with the two strains from papaw were the most successful; no inoculation failed. When inoculations were made with these strains, discoloration occurred around the points of inoculation within 4 days and latex oozed from the discoloured area. Hyphae appeared on the surface shortly afterwards, and sporangia and chlamydospores were formed in large numbers. The progress of the disease was rapid, and the whole pod was covered with a dense mycelium in 10 days.

Two inoculations with the rubber strain, and one with the strain from *Odontadenia*, progressed similarly though less rapidly. Not until

the seventh or eighth day did it become evident that the inoculations had taken, but from then onwards the progress of the disease was rapid. No inoculation with the strains from breadfruit and *Dendrobium* was successful.

One inoculation with the cacao strain gave a peculiar result. The cells below the point of inoculation collapsed, resulting in a depression at the surface as though it had been pressed in with the thumb. There was no discoloration and except for the cup-like depression the pod appeared healthy. This area was cut through with a clean knife three weeks after the inoculation had been made. On the following day sporangia were present on the cut surface.

Successful inoculations were obtained with all strains when the papaw fruits were wounded.

Hevea pods. *Hevea* pods were attacked by all the strains, even when the pods were not wounded. The strain from rubber was the most virulent, through the *Dendrobium* strain almost equalled it in virulence. Pods inoculated with these strains were discoloured within 2 or 3 days from inoculation, and sporangia appeared on the surface within 5 days. Hyphae appeared on the surface of pods infected by the strains from cacao, breadfruit and papaw 2 or 3 days later than they appeared on pods inoculated with the strains from *Dendrobium* or rubber. The growths from the papaw strains were the weakest ; in some cases only scattered pustules had formed by the time pods infected with the other strains were entirely covered with mycelium.

Of 12 inoculations with each strain on unwounded pods, 1 with the *Dendrobium*, 3 each with the cacao and *Odontadenia*, and 4 each with the papaw and breadfruit strains were unsuccessful. On wounded pods all inoculations were successful.

Breadfruit. Four inoculations were made with each strain on unwounded bread-fruits. All inoculations with the strain from breadfruit, 3 with the *Odontadenia*, and 2 each with the papaw and *Dendrobium* strains were successful, but no infections were obtained with the strains from cacao or rubber. Two inoculations with the last-named strains were also made on wounded fruits ; both inoculations with the rubber strain took readily, but neither with the cacao strain was effective.

General. Inoculation experiments were not carried out on *Dendrobium* or *Odontadenia* plants. The results of the inoculations on cacao, rubber, breadfruit, and papaw fruits indicate that these fruits are most readily attacked by the strains which were originally isolated from them, and that the majority of the other strains will infect these fruits under suitable conditions. In general, *Hevea* pods are more readily attacked by all strains than are the other fruits used in these experiments. Though

the various strains readily attack *Hevea* pods, the *Phytophthora* from *Hevea* does not attack other fruits with equal readiness.

The results are similar to those obtained by Rutgers, who reported "The Phytophthoras from *Hevea*, cacao and nutmeg belong to the same species; only, the line isolated from cacao proved to be more virulent for cacao and *Hevea* and the one isolated from nutmeg more virulent for nutmeg."

Though the *Phytophthora* from cacao will readily infect *Hevea* pods under laboratory conditions, it would appear from general observations that a similar infection does not readily occur in nature. At the Peradeniya Experiment Station, pod rot and canker are prevalent in the cacao trees, but the *Hevea* trees are rarely affected by pod disease, though cases of claret-coloured canker and black stripe disease occur.

The virulence of *Phytophthora* diseases depends to a very large extent upon climatic conditions, and possibly, in some cases, on the stage of development of the fruit at the time of attack. In the low-country of Ceylon, *Hevea* fruits are annually affected by pod rot during the South-west monsoon, though the attack is more severe in some years than in others. At Peradeniya, pod rot and leaf-fall of *Hevea* are rare. The fruits are formed later at Peradeniya than in the low-country, owing to the greater elevation. It was considered that the later ripening of the fruit at Peradeniya was one of the causes of the absence of *Phytophthora* disease, the fruits not having reached a suitable stage of development at the time climatic conditions were most favourable for attack by the fungus. The monsoon rains this year (1923), however, were very prolonged, but still neither pod rot nor leaf-fall became evident; consequently, the late development of the pods cannot be regarded as a sufficient explanation of the non-appearance of the fruit disease.

That the *Phytophthora* from cacao will under suitable conditions readily attack *Hevea* pods in the field is notably demonstrated by Rutger's experiments, already quoted, which had to be stopped after three weeks, as 50 per cent of the fruits in the field had become infected.

The restricted occurrence of other *Phytophthora* diseases is also difficult of explanation. The breadfruit disease has been reported from the Southern Province only, although isolated trees are grown throughout the low-country wet zone and up to 2,000 ft. Though surrounded by *Hevea* attacked by pod rot disease, the breadfruit, in many cases, escapes infection. Similarly, the papaw fruit disease has been reported only from Peradeniya, though papaw trees are grown in both rubber and cacao districts. A *Phytophthora* has only once been found on *Odontadenia*; then it occurred on one of two plants growing near together and surrounded by *Hevea* trees affected by pod rot.

It would appear from the above facts that though a strain from one host plant may attack another host under laboratory conditions, it does not readily do so in nature ; and that the virulence of any strain depends to a large extent on unknown external conditions.

DISCUSSION.

The strains of *Phytophthora* used in these investigations may be divided into two groups by their morphological characters when grown in culture on maize-meal agar. The strains from cacao and from papaw constitute one group, which for convenience has been termed the cacao group ; the strains from *Hevea*, *Dendrobium*, *Odontadenia*, and bread- fruit form the other, termed the rubber group. The cacao group is distinguished from the rubber group by the larger chlamydospores, the smaller length to width ratio of the sporangia, and by the relatively greater production of chlamydospores.

Such grouping divides the strains into two distinct physiological races, (in so far as the formation of oospores is dependent upon physiological characters), as oospores are produced only in those mixed cultures which contain one member from each group. In other words, the members of one group are all of the same sex, but of opposite sex to those of the other group. If the members of the cacao group are regarded as female, then those of the rubber group are male.

The strain from cacao is the type of the species, *P. Faberi*. If all the strains are regarded as belonging to the same species, then the production of oospores in mixed cultures may be explained on the assumption of heterothallism. The two thalli, however, are differentiated, when grown in certain environments, by definite morphological characters. In this respect the heterothallism is different from that observed in such genera as *Mucor* and *Coprinus*, in which the + and — races are usually identical morphologically.

On the other hand, if the members of the two groups, owing to morphological differences, are considered to constitute distinct species, then the oospores must be regarded as hybrid. Whether the production of oospores in mixed culture must be interpreted on the assumption of heterothallism or of hybridism will depend upon whether the members of the two groups are regarded as belonging to one or more species, and, consequently, upon the definition of a species.

To the systematist, a species consists of individuals with similar morphological characters. The characters most useful for taxonomic purposes are those which remain constant under all conditions and are not correlated with certain adaptations to habitat. Plastic characters, which vary with external conditions, are of less value, the value decreasing

as their plasticity increases. Physiological characters, though useful for the separation of distinct strains, cannot yet be regarded as adequate criteria for the differentiation of species. Specific diagnosis must therefore be based on constant structural characters.

The most critical descriptive characters in the systematic treatment of the genus *Phytophthora* are undoubtedly those exhibited by the sexual reproductive organs. Rosenbaum gives the following characters, which may be conveniently used in separating the various species, arranged as nearly as possible in the order of their importance. "(1) The size and morphology of the sexual reproductive bodies, conidia, chlamydospores and other structures; (2) shape of the terminal papillum in the conidium; (3) the ratio of the length to the width in the conidia; (4) variation in the mycelium; and (5) the microscopic growth, time of appearance of spores, and kind of spore forms produced on various media."

The characters by which the strains forming the cacao group are separated from those of the rubber group, viz., the length to width ratios of the sporangia and the size of the chlamydospores, are not constant under all conditions. On some media it is impossible to distinguish the strains by these characters. Owing to the plasticity of these characters, it is doubtful whether they alone are sufficiently marked to delimit the groups specifically.

With regard to the cacao group, if the limits of a species are narrowly set, it would be possible to differentiate the papaw strains from *P. Faberi* morphologically, by their greater development of aerial mycelium and the smaller production of spores, both sporangia and chlamydospores, when grown on certain media. Though such a differentiation may be supported by certain physiological characters, it is doubtful whether the separation of the papaw strains from *P. Faberi*, and the formation of a new species to accommodate them, would serve any useful purpose in systematic mycology. They are best regarded as varieties of *P. Faberi*.

But whether the morphological characters of the strains in the rubber group exhibit sufficiently marked differences to justify their exclusion from *P. Faberi* is a debateable question.

The oospores described in this paper are morphologically identical with those found by Ashby, when he grew *P. Faberi*, from cacao, in mixed culture with a strain of *Phytophthora* isolated from coconut, or from cotton bolls, or with *P. parasitica*. *P. parasitica* forms oospores in pure culture which are substantially smaller than those obtained when this species is grown in mixed culture with *P. Faberi*. The strains from coconut and cotton bolls are morphologically very similar to *P. Faberi* (from cacao), and do not produce oospores in pure culture. The oospores in all these mixed cultures are alike. The fact that the oospores of the

P. Faberi × *P. parasitica* cross are identical with those obtained when *P. Faberi* is grown in mixed culture with either of the strains from coconut or cotton bolls, indicates that their size and characters are determined by *P. Faberi*, and that they may therefore be considered as actually the oospores of *P. Faberi*.

In the present investigation, the occurrence of similar oospores in mixed cultures, in which the strains from papaw have been substituted for *P. Faberi* from cacao, supports the view that the strains from cacao and from papaw must be referred to the same species, notwithstanding that they have different host relationships.

Ashby refers the strain from coconut to the species *P. palmivora*. It would appear from his description, that the cacao fungus (*P. Faberi*) differs from both *P. palmivora* and the strain from cotton bolls in growing less vigorously, and in developing sporangia less luxuriantly but chlamydospores more freely, as well as in not forming the characteristic mycelial aggregates that are usual in cultures of the coconut form. In all other respects, including the conidiophores and shape and size of the sporangia, *P. Faberi* cannot be distinguished in pure culture from *P. palmivora* and the cotton boll fungus, but these last two have not been found capable of infecting cacao pods.

Ashby concludes that the cotton boll *Phytophthora* is apparently identical with *P. palmivora*; that the absence of oospores, both in pure and mixed cultures of this species, and some growth differences, as well as its inability to infect cacao pods, distinguish it from *P. Faberi*. He consequently regards it as no more justifiable to include it in one species with the latter than to unite it with *P. Meadii*.

In that *P. palmivora* develops sporangia more freely, and chlamydospores less readily, than the cacao *Phytophthora*, it resembles those strains forming the rubber group under investigation. The length to width ratio of the sporangia of *P. palmivora* in cultures on Lima bean agar which have reached their full growth (2-3 weeks) is given (1) as 1.52-1.57, though in young cultures (under a week) the length is relatively greater, the ratio being 1.75-1.77. The smaller ratio agrees closely with those found by me for the cacao group, and the larger approximates those of the rubber group given in Table 4. The change in the length to width ratio of the sporangia with the increase in age of the cultures indicates that the shape of the sporangia is not a sufficiently constant character for the differentiation of species.

P. palmivora differs from *P. Faberi* in minor growth characters, and in attacking coconut tissues readily whereas it will not attack cacao pods. As oospores are formed when it is grown in mixed cultures with the cacao fungus, it would appear to be closely allied with the strains

forming the rubber group. The strains of this group, therefore, were inoculated on wounded, young coconut leaflets and fruits, but without success. Hence *P. palmivora* differs from the strains forming the rubber group as regards host relationship.

On the other hand, one wounded coconut fruit, of three inoculated with the cacao strain, was successfully infected. A dark brown discoloration spread from the point of inoculation until the whole fruit was discoloured. The progress of the discoloration was followed closely by the development of a thick mycelium bearing sporangia, on the surface. It would appear, therefore, that *P. palmivora* is closely related to *P. Faberi*, and there seem to be small grounds for the separation of these species morphologically. If, however, the two species are amalgamated, the name *P. palmivora* would take precedence.

In South India and Burma, the species of *Phytophthora* which causes disease of *Hevea* trees has been referred to *P. Meadii*. This species was described by McRae (19) as the cause of wilting of the leaves, fruit rot, leaf fall, bark rot, and partial die-back of the branches of *Hevea* in South India. When first discovered, the fungus was suspected to be *P. Faberi* (18), owing to the similarity of the two species, but a careful study by McRae, of parallel cultures of the South Indian fungus and *P. Faberi* from cacao from Ceylon, showed certain specific differences.

"The sporangium of *P. Faberi* is usually slightly nearer the spherical shape than that of *P. Meadii*. The papilla of *P. Faberi* is, as a rule, more protuberant than that of *P. Meadii*, and the base of the sporangium of the former has a cellulose plug much more frequently than has the latter. .....The main differences, then, between the two fungi are that the oospore of *P. Faberi* almost completely fills the oogonial wall and that no antheridium is present, while in *P. Meadii* the oospore lies loose within the oogonial wall, and a persistent antheridium is invariably present. The differences are so distinct that the two cannot be regarded as the same species"(19). McRae relied on the descriptions of von Faber, Coleman, and Rorer for the description of the oospores of *P. Faberi*, and, as already stated, these probably refer to chlamydospores and not to true oospores. In his own cultures of *P. Faberi*, he found resting conidia only. Consequently, the main difference between *P. Faberi* and *P. Meadii* is that the latter produces sexual spores in pure culture whereas the former does not.

McRae's cross inoculation experiments showed that "under exactly similar conditions *Hevea* fruits were infected readily both by *P. Faberi* and *P. Meadii*, while cacao fruits were infected readily by the former and with difficulty by the latter." These results are similar to those obtained

in infection experiments carried out in Ceylon with the strains from cacao and rubber respectively.

In Burma (11) the *Phytophthora* which causes pod rot, leaf fall and bark rot does not form antheridia, oogonia or oospores, but it does produce chlamydospores in culture and on fruits. In these respects it differs from *P. Meadii* of South India, which produces oospores but not chlamydospores. Otherwise, the two Phytophthoras are similar. It is, however, of interest that "a culture of *P. Meadii* sent to Pusa produced resting conidia there soon after its arrival, and has continued to do so in subsequent sub-cultures. They have appeared in French-bean agar and oat-juice agar, though never so copiously as in cultures of the Burma *Phytophthora* on *Hevea*."(19).

Concerning this, McRae states, "the fact that *P. Meadii* can produce resting conidia rather confirms the identity of the Phytophthoras from Burma and from South India. I have made measurements of the resting conidia from the cultures of the Burma *Phytophthora* and from that of the South Indian *Phytophthora* returned to me by Dastur, and the measurements come very close together. These resting conidia also come fairly close to those of *P. Faberi* in size."

The strain of *Phytophthora* isolated from rubber pods in Ceylon closely resembles the Burma fungus, but differs from the South Indian species in that it does not produce oospores in pure culture, and by forming chlamydospores more readily. The production of chlamydospores would appear to depend to a large extent on climatic conditions, as the South Indian fungus does not produce them at Coimbatore but does when cultures are sent to Pusa.

P. Meadii differs from *P. Faberi* from cacao in forming oospores in pure culture, in certain minor morphological characters, and by not readily infecting cacao pods. If, however, the oospores which occur in mixed cultures containing *P. Faberi* are actually those of *P. Faberi*, as Ashby's observations and the present investigations would indicate, then the morphological difference between *P. Meadii* and *P. Faberi* is considerably reduced, as the oospores of these two species are somewhat similar in size. McRae gives the measurements of the oospores of *P. Meadii* on French-bean agar as 16.4-32.8 × 15.2--32 μ, with an average of 25.5×25 μ; and on *Hevea* fruits as 16-32 × 16-32 μ with an average of 21 × 20.5 μ (cf. Table 6)

Cross inoculations with the strain from rubber in Ceylon give results very similar to those obtained by McRae and Dastur with the Phytophthoras of South India and Burma respectively. The disease in South India, however, would appear to be more serious than it is in Ceylon, as when the trees are attacked, they dry up so that it is hardly

worth while tapping them ; in Ceylon it is usually not so. In 1919, Petch (27) reported *Phytophthora Meadii* from one district in Ceylon. This species was identified by the presence of oogonia on the *Hevea* fruits. Concerning the physiological effect of this species on *Hevea* he states " As far as observations have gone, the difference in the effect of the two species is very marked : during the leaf fall and pod disease caused by *Phytophthora Faberi*, the flow of latex is not notably affected ; but in attacks of *Phytophthora Meadii*, the latex flow diminishes to such an extent that it is scarcely worth while to tap." Although *P. Faberi* and *P. Meadii* are in many respects very similar, their physiological effects on the rubber tree are very different. Both species occur in Ceylon, but *P. Meadii* has rarely been found.

There are, therefore, equally strong arguments against, as in support of, referring the *Phytophthora* isolated from the ordinary form of pod-rot of *Hevea* in Ceylon to the species *P. Meadii*. The strain from Bread-fruit is morphologically identical with the Ceylon strain from *Hevea*, but there is little reason for referring this strain to *P. Meadii* in preference to *P. Faberi*.

Though it may be idle to speculate on the origin of *P. Meadii*, it is of interest that McRae, in discussing its possible origin, favours the idea that it " was introduced into South India along with plants and seed (possibly fruits*)that were imported in considerable numbers from Ceylon." The *Phytophthora* from rubber in Ceylon, however, does not produce oospores, except when grown in mixed cultures with *P. Faberi* from cacao. Until these spores have been germinated and the nature of the resulting fungus investigated, the Ceylon *Phytophthora* found on the ordinary form of pod-rot must be regarded as distinct from *P. Meadii*.

Many pathogenic fungi exhibit the phenomenon of specialised parasitism. Forms which differ only slightly or not at all in structure, and which must be included within the limits of a single species as ordinarily understood, may differ markedly in host relationships. The distinct physiological races of many of the rust fungi, e. g. *Puccinia graminis*, are generally recognised. As the present conception of a species is based on morphological characters alone, these forms are regarded as biological varieties. Biological varieties, therefore, differ from species, in that the latter have considerable structural differences by which they can be distinguished whereas the former have not.

For the present, therefore, it would appear preferable to regard the strains from cacao, papaw, rubber, *Dendrobium*, *Odontadenia*, and bread-fruit in Ceylon as biological varieties of *P. Faberi*, the strain from *Den-*

* It would appear scarcely possible that *Hevea fruits* would be sent to India from Ceylon—C. H. G.

drobium being probably identical with that from rubber. If this view is accepted, the presence of oospores in mixed cultures may be explained on the assumption of heterothallism, the strains from cacao and papaw being + races and those from rubber, *Odontadenia*, and bread-fruit — races.

SUMMARY.

1. A comparative study has been made of the strains of *Phytophthora* isolated from cacao, papaw, *Hevea*, *Dendrobium*, *Odontadenia*, and breadfruit in Ceylon.
2. Spore dimensions are influenced by environmental conditions. The value of spore measurements as a means of delineating species of *Phytophthora* is considerably diminished, owing to the variable measurements obtained when strains are grown on different substrata, or under different environmental conditions.
3. Oospores were not found in pure cultures, but were present in mixed cultures, in which certain strains were grown in combination.
4. The strains used in these investigations are regarded as biological varieties of *P. Faberi*. The presence of oospores in mixed cultures is explained on the assumption of heterothallism; the strains from cacao and papaw being + races and those from *Hevea*, *Dendrobium*, *Odontadenia*, and breadfruit — races.

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EXPLANATION OF PLATE X.

Fig. 1. Sporangiophore of the strain from *Hevea*, ×130.
2. Sporangiophore of the strain from *Dendrobium*, ×130.
3 & 4. Sporangiophore of the strain from Cacao, ×130.
5. Sporangiophore of the strain from *Hevea*, showing small swellings, 450.
6. Bladder-like termination of a sporangiophore of the strain from Papaw fruit, ×470.
7. Typical sporangium of the rubber strain, ×500.
8. Typical sporangium of the cacao strain, ×500.
9. Irregular thickening of the inner wall of a chlamydospore, ×470
10. Irregular thickening of a sporangium wall, ×380.
11. A sporangium producing secondary and tertiary sporangia, ×380.
12. A chlamydospore producing a secondary sporangium, ×380.
13. A germinating chlamydospore, ×470
14-16. Oospores from mixed cultures, ×700.
17. Part of a stromatoid body with oospores, ×300.
18. Small stromatoid body with oospores, ×300.

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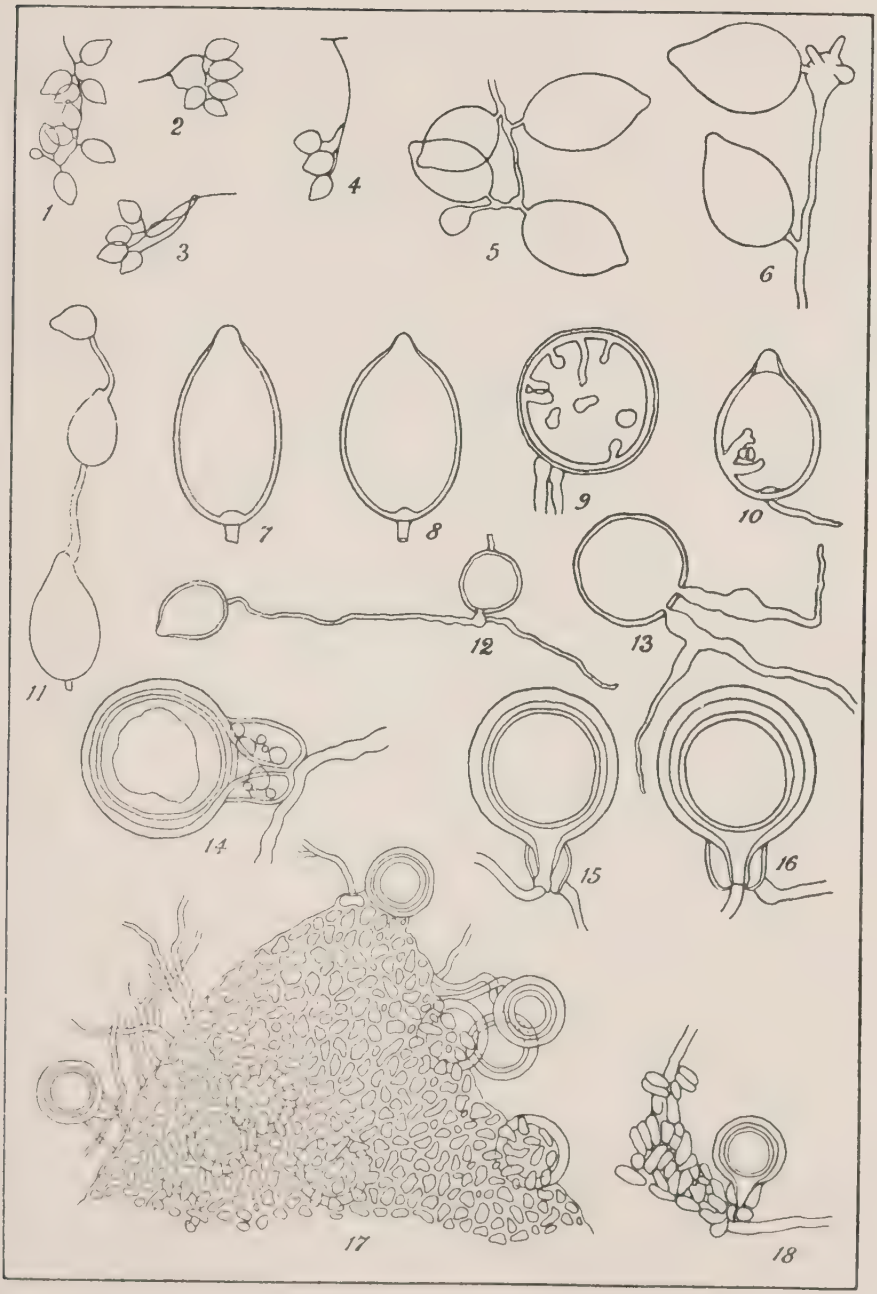

PHYTOPHTHORA FABERI.

Notes on Some Ceylon Dipterocarpeae.

BY

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WITH ONE PLATE

The following notes consist mainly of descriptions of species, the identity of which had been doubtful up to date owing either to the insufficiency of good specimens or to the absence of flowers or fruit. It also includes the descriptions of flowers of *Dipterocarpus scabridus* Thw. and *Stemonoporus revolutus* Trimen which had not hitherto been published, and of two new combinations *Isoptera lissophylla* and *Vatica Lewisiana*.

Dipterocarpus scabridus Thw., Enum. p. 34 (1858)., C. P. 2692, 2590 (in part) ; Trimen, Fl. Ceyl., 1 (1893), 115.

" A large tree ; young twigs with copious adpressed hairs ; 1.6-9 in., oblong-lanceolate, rounded or acute at base, shortly acuminate, acute, nearly entire, glabrous above, ciliate, veins hairy beneath, lat. veins 12-18, petioles 0.75 in. or more, densely adpressed hairy " (Trimen).

Inflorescence a branched, axillary, lax raceme, shorter than the leaves, bearing several large sessile flowers. Rachis of raceme densely stellate-tomentose. Calyx of 5 united, light green sepals : calyx tube the shape of a 5-sided pyramid, 0.5 in. long, winged, stellate-pubescent : calyx lobes of 2 sizes, two 0. 8-1 in. long, 0.2 in. broad, three 0.25 in. long, 0.3 in. broad, almost triangular in outline ; all lobes densely stellate-pubescent with obtuse, rounded apices and entire sinuate margins. Corolla of five, free, imbricating, lanceolate-oblong petals, 1.5 in. long and 0.5 in. at broadest, tapering for a length of 0.5 in. towards the base : petals leathery, creamy, with a well-marked pink colour half way down the centre of the petals ; both surfaces densely silky tomentose, especially towards the apex ; veins distinct ; apex rounded, reflexed ; margins entire revolute ; bases of petals closely pressed together forming a tube 0.5 in. across, resembling a gamopetalous corolla, the apices of the petals spreading out : the whole deciduous and having the appearance of an apocynaceous corolla. Stamens 30 ; filaments triangular, flat at base

dark brown, closely pressed together, free. Anthers yellow, 0.2 in. long, slightly pubescent, united at their bases, dorsifixed, introrse, dehiscing by longitudinal slits : connective prolonged into a long curved process 0.2 in. long. Ovary silky-tomentose, 5-ridged, 3-celled with 2 ovules in each. Style 0.5 in. long, silky-tomentose. Stigma 2-lobed. " Fruit calyx 4-5 in., tube oblong-ovoid, with 5 strong marked, broad, undulated, vertical wings, generally reaching to the base, slightly stellate-pubescent, lobe wings 3-4 in., somewhat undulated, mottled, smaller obes oblong-rotundate, much undulated and crumpled"(Trimen).

Endemic. Near Ratnapura. Flowers collected in April 1923, in the Botanic Gardens, Peradeniya.

Doona venulosa Thw., Enum. p. 402 (1864), C. P. 3675 ; Trimen Fl. Ceyl., 1 (1893), 123.

Tree large, young parts glabrous and bark of twigs dark; l. 2.5-3.25 in., oval or ovate-oval, rounded at base, suddenly acuminate, lat. veins 6-8, the lower very oblique, ascending, tertiary connecting veinlets very prominent on upper surface.

Flowers 0.75 in. diameter, white, with articulated peduncles in terminal glabrous panicles. Sepals 5 united : 3 outer larger, 0.5 in. long, oblong-obtuse, distinctly veined, apex rounded, of uniform thickness, margins not ciliate ; 2 inner smaller, 0.15 in. long, broadly ovate, less thick towards the fringed margins. Petals 5, free, fleshy, 0.5 in. long, oblong, obtuse, pubescent with adpressed hairs on outer surface, glabrous within. Stamens 15, filaments united at the base into a ring 0.08 in. high, then free for a very short length : anthers introrse, valves 0.08 in. long, equal, oblong, dehiscing laterally ; connective prolonged into a club-shaped process 0.04 in. long. Ovary glabrous, ovate ; style long, sparsely hairy with adpressed hairs ; stigma blunt. Fruit 3-winged, the 2 other fruiting sepals inconspicuous ; wings obscurely veined, closely adpressed to nut at their resinous thickened bases ; cotyledons much plicate and convoluted.

Thwaites named the plant provisionally, neither flowers nor fruit being then available.

Endemic. South of the Island. Flowers obtained, April 1923, R.B.G., Peradeniya.

Hopea cordifolia Trim., Fl. Ceyl., 1 (1893), 126 ; *Vatica (?) cordifolia* Thw., Enum. p. 404 (1864) ; C.P. 3726. Mendora, S.

" A very large tree, bark thick, with deep, longitudinal fissures nearly black, young parts softly pubescent ; l. large, 5-7 in., ovate-oblong, strongly cordate at base, subacute, glabrous, shining above, lat. veins 5-7, oblique, conspicuous beneath, with glandular pits in 2 or 3 of their axils ;

petioles 1 in., rugose, stip. very small, subulate, caducous." (Trimen); fl. about 0.2 in. in diameter, on erect axillary panicles of 3 types : (a) the usual form arising in the axil of a leaf with flowers on the primary branches of the inflorescence ; (b) two distinct panicles arising in the axil of the same leaf ; (c) two distinct panicles arising on the opposite side of the stem to the leaf. In the last case the growth of the stem is continued sympodially. Rachis of inflorescence smooth ; pedicel about 0.04 in., dark coloured, rough, thick. Calyx of 5 free imbricating sepals : 3 sepals, which do not enlarge in fruit, broadly oval, with an acute apex, slightly hairy on both surfaces and with margins fringed with hairs (Fig. A 4) ; the other 2 oval-oblong with obtuse apices and margins not fringed with hairs (Fig. A 3) ; all sepals fleshy and thick at base. Corolla of 5 imbricating, falcate petals, slightly connate at the base. Petals 0.4 in. long, 0.12 in. broad, glabrous on inner surface, pubescent on outer ; apex and base obtuse, margins entire, fringed with hairs. Stamens 15 : filaments (Fig. A 2) slender, slightly connate at their flat and broad bases : anthers introrse, oblong, dorsifixed ; connective prolonged into a bristle twice the length of the anthers. Ovary minute, glabrous, 3-locular with 2 ovules in each loculus. Style as long as the ovary. Fruit a winged nut. Two sepals enlarged to about 3.5 in., oval oblong, 9-veined, apex rounded, not tapering towards the base. Nut 0.5 in. beaked.

Endemic. Intermediate region 1500-2000 ft., very rare. Along banks of streams at Tanamilwila and Telula, near the Wellaway River, in Atkalan Korale.

Flowers were first obtained in April 1912 by Mr. F. Lewis on the banks of the Kirinda Ganga at Tanamilwala on the confines of the Uva Province. The following passage from his communication of 6th May 1912 to the late Dr. Lock, then acting Director of Botanic Gardens, throws an interesting light on the history of the discovery and of the identity of this plant. " It may be interesting to note that leaves only of this splendid Dipterocarp were first obtained by Thwaites over 50 years ago. In 1891 my old chief, Broun, (then Conservator of Forests) and I found some decayed fruits of what we believed to be this species and sent them to Trimen. Several years later I secured the fruits and I figured them, and now from the identical spot where, 21 years ago, Broun and I got our fruit material I secured the flowers. Oddly enough these were collected in the same month, April ! You will see by the material sent that the genus *Hopea* is established for this important tree, which before was doubtful."

Isoptera lissophylla (Thw.) Livera, comb. nov.; *Shorea lissophylla* Thw., Enum. p. 402 (1864) ; C.P. 3407 ; Trimen, Fl. Ceyl , 1 (1893) 117.

Yakahalu, S. Arbor ingens, glabra ; ramulae nigrescentes ; folia ovata vel ovato-rotundata vel oblonga, abrupte breviter rostrata, acuta, basibus latis, rotundatis vel subcordatis, 3-5 poll. longa, 0.5-3 poll. lata, venis primariis utrinque circiter 7, his cum costa superne parum depressis, subtus prominentibus, venulis inconspicuis ; petiolus semipollicarus, rugulosus. Paniculae ramis glabris, multiflorae ; pedicellum brevissimum et cum alabastris minute incano-pubescens ; flores 0.5 poll. long., 0.75 poll. lat., incano-pubescentes ; sepali 5, basin liberi, imbricati, ovati ; petali 5, liberi, imbricati, oblongi, marginibus revolutis, externe pubescentes, interne glabri. Stamina 35 : antherae introrsae, non barbatae sed connectivis productis in barbatis spicis. Ovarium oblongum, minute incano-pubescens, 3-loculare, ovulae 6. Stylus brevis. Fig. B.

Thwaites had no fruit when he named this species, and Trimen says, in Fl. Ceylon, I (1893), 118, "fruit not seen." Fruit was first collected by Broun in July, 1893. Roxburgh, in Gaertn. f., Fruct., III., 48, t. 186, describes the genus *Shorea* thus : " Cal. inferus, pentaphyllus imbricatus, foliolis squamiformibus, per maturitate ovario arcte adpressis, basi gibbis, dorso incrassatis, margine scariosis ad ovarii apicem angustatis, et inde in ligulas sensim latiores longas foliaceas lineari-nervosas apice rotundatas productis." This definition is based on the characters of the calyx, which develops into wings in the mature fruit : it is supported by a figure, t. 186.

The earliest mention of fruit of *S. lissophylla* Thw. is in Brandis' Enumeration of the Dipterocarpaceae, Journ. Linn. Soc.,XXXI (1895), 77, where that author says that the other characters of this plant would place it under *Eushorea*. " But A. L. Broun has sent me a sketch of the fruit with short wings, which places it under the section *Brachyptera*. It is, however, an anomalous species of this section." On comparing Broun's fruit with those I have obtained locally, I find that Broun had collected young fruits in which the ripened ovary had not outgrown the calyx in size, and thus this error of determination is easily accounted for. Brandis (*l.c.*), in enumerating the characters of the section *Brachyptera*, says, " segments of fruiting calyx shorter than twice the length of the fruit," and evidently he means that the segments of the fruiting calyx are longer than the fruit. This is not so in *S. lissophylla* Thw. Also the other 6 species of *Shorea* enumerated under this section have 15 stamens each, whereas *S. lissophylla* Thw. has 35.

On the other hand, following Brandis' key (*op. cit.*) pp. 2-3, based on a comparison of all the available species of Dipterocarps, we find that our plant has all the characters enumerated there under *Isoptera*, viz.: " Lobes of fruiting calyx shorter than fruit, round, unequal ; stamens 30-36 ; appendix of connective ciliate ; large stylopodium." Our plant is therefore

an *Isoptera*. This conclusion is confirmed by its possessing characters agreeing with Scheffer's definition of the genus *Isoptera* in Annales Jard. Bot. Buitenzorg, VI (1887), 222, thus : " Calycis floridi tubus brevissimus, toro adnatus ; laciniae ovato-rotundatae, imbricatae ; fructiferi tubus haud auctus, laciniae omnes auctae, horizontaliter patentes, haud aliformes ; 3 latiores rotundatae, 2 angustiores. Stamina 30-36, antheris ovatis, loculis basi divergentis, acutis, valvis aequalibus, connectivo producto setifero. Ovarium 3-loculare loculis 2-ovulatis ; stylus brevis, teres apice 3-angulatus. Fructus coriaceus indehiscens monospermus, calycis laciniis haud inclusus. Semen globosum ; cotyledones crassocarnosae, oleosae, aequales, radiculam superam includentes. Arbores resiniferae. Folia integerrima, parallele penninervia. Paniculae axillares et terminales."

On anatomical grounds this determination is strengthened. Burck, in his " Recapitulation des caractéres anatomiques de la famille et des genres Dipterocarpées," p. 190, Annales Jard. Bot. Buitenzorg, VI (1887), has the following comparison of the internal structure of *Shorea* and *Isoptera*.

	Shorea	*Isoptera.*
Canaux medullaires	Systéme de canaux anastomosés dans la moelle de la tige.	en grand nombre, séparés l'un de l'autre.
Petiole	Anneau externe ouverte vers le côte superieur du limbe.	Anneau externe ferme.

Our species has medullary canals which do not anastomose, and a closed ring of vascular tissue in the petiole.

A large tree with an almost cylindrical stem. Branches glabrous, profuse, black. Bark with deep longitudinal fissures prior to peeling off. Leaves alternate, petiolate ; petiole 0.3-0.75 in., subpeltate, thick, glabrous, rugose ; leaves 3-5 in. long, 2-3 in. wide, broadly oval or oblong, base rounded or subcordate, apex abruptly and shortly acuminate, acute ; margins entire, slightly revolute ; coriaceous, smooth, shining on both surfaces, paler beneath ; midrib and 7 pairs of veins prominent beneath, channelled above. Young shoots softly pubescent. Inflorescence of several drooping flowers in axillary or terminal panicles shorter than the leaves, in the axils of which they arise : rachis of inflorescence sparsely pubescent ; pedicel very short, 0.08 in. Flowers (Fig. B.) yellow, about 0.5 in. long, 0.75 in. across, with a not unpleasant odour. Calyx of 5 free, imbricating, broadly ovate, fleshy sepals with acute apices and entire margins ; outer surface stellate-pubescent, inner glabrous and shining. Corolla of 5 free, yellow, oblong, fleshy, imbricating petals, about 0.5 in.

long, 0.05 in. broad ; at about 0.1 in. from the base the margins revolute for a length of 0.2 in., and then straight again ; apex of petals obtuse, outer surface silky-tomentose, inner glabrous and shining. Stamens 35 (Fig. B. 3.) : lower part of filaments green, fleshy, flat, rectangular, united at their bases ; upper part short, slender ; anthers introrse, of 2 equal valves diverging at the base, attached dorsally to the connective, which is prolonged into a pointed process set with bristles. Ovary oblong, small, silky-pubescent, 3-locular with 2 ovules in each : style very short, terete ; stigma 3-angled. Fruit a nut, not winged, surrounded at base by the slightly enlarged sepals, of which 3 are broader and rounded, and 2 narrower. Nut greyish, silky-pubescent, 0.5-0.75 in. long, 0.25-0.4 in. broad.

Endemic. Moist low-country ; rather rare. " Commonest Dipterocarp on the banks of the Bentota river." Recent specimens from R.B.G., Peradeniya, April 1923.

Balanocarpus zeylanicus Trimen, in Journ. Bot., XXVII (1889), 161 ; Trimen, Fl. Ceylon, 1 (1893), 130 ; *Shorea brevipetiolaris* Thw. mss., in Journ. Bot., XXIII (1885), 205.

Thwaites, in the absence of fruit, doubtfully named this species *Shorea brevipetiolaris*. In 1889, Trimen secured fruit and placed it " with some little doubt in Beddome's genus *Balanocarpus* founded on two species," naming it *B.* (?) *zeylanicus*. In 1895, Brandis (*op. cit.* p. 108) examined 13 other species of *Balanocarpus* and defined the limits of the genus to include the Ceylon species, giving among other characters of the genus, " Stamens 10 or 15."

All these authors state that the Ceylon species has 15 stamens, though there is a sheet, annotated by Trimen, in the Peradeniya Herbarium, of a plant collected in the Botanic Gardens with only 10 stamens. Trimen thought this a different species. On re-examining this specimen I find that some flowers have 15 stamens. This variation in the number of stamens has also occurred in another specimen collected in the Botanic Gardens. These trees were planted out by Thwaites, and Trimen refers to them in Journ. Bot., XXIII (1885), 205. None of the authors mentioned had seen the fully developed flower, and their descriptions were made from young buds only. The description given below is from fully opened flowers.

A small tree with smooth dark bark, young shoots strongly pubescent or glabrous. Leaves 4-5 in., ovate or lanceolate-ovate, glabrous ; lat. veins about 6 pairs, curved, prominent beneath, with occasional glandular pits in their axils ; apex of leaf acuminate, obtuse ; base rounded or subcordate ; margins undulate ; petiole thick, rugose, glabrous or densely

pubescent, 0.25-0.3 in. long. Inflorescence of slender, pubescent, spreading panicles. Flowers shortly pedicellate, secund. Calyx of 5 imbricating sepals, slightly united at the base and of 2 sizes : two outer broadly ovate, almost triangular, 0.04 in. long, 0.04 in. broad, uniformly thick, apex acute ; inner semicircular 0.04 in. long, .06 in. broad, with membranous sinuate margins and obtuse apex; all sepals glabrous. Corolla of 5 free, contorted, fleshy, glabrous, falcate petals, 0.04 in. long, 0.02 in. broad, margin sinuous, base broad, tapering to the rounded apex. Stamens 10-15 : either in 2 rows of 5 each or of 10 outer and 5 inner ; filaments flat at base and united round the ovary, the outer filaments shorter. Anthers introrse, valves equal, connective prolonged to a curved pointed awn equal in length to the anther. Ovary 0.04 in. long, ovoid, no stylopodium, faintly puberulous, narrowed into a tapering style 0.04 in. long. Ovary 1-locular with 4 pear-shaped ovules attached to the axis half way up its length. Fruit ovoid, acute, strongly apiculate ; sepals persistent, enlarged, forming a spreading cup ; pericarp thin, brittle.

Endemic. Very rare ; only known from the summit of Doluwe Kande.

Vatica (Retinodendron) Lewisiana (Trim.) Livera, comb. nov.: *Stemonoporus Lewisianus* Trim. Mss., in Hooker's Trim. Fl. Ceylon, V. (1900), 383.

Arbor ingens, cortex asper. Folia coriacea, elliptica, glabra, superne nitida, pubescens infero, 2.5-3 poll. longa, 1.5 poll. lata, basin rotundata, marginibus revolutis, apex acutus, acuminatus ; petiolus duriusculus, tomentosus, superne canaliculatus. Paniculae axillares : flores pauci, albi, breviter pedunculati. Calyx valvatus, 5-partitus : sepali basin uniti. lanceolati. Petali elliptici, imbricati, saltem externi margines pubescentes. Stam. 15 : antherae introrsae, dehiscentes laterale, externae valvae majores ; connectivi producti. Fructus cum auctis revolutis sepalis.

Petiole 0.5 in., long. Leaves with slightly acuminate apices ; lower surface shortly and closely stellate-tomentose,upper smooth and shining ; secondary veins several, prominent and parallel ; blade 2.5-3 in. long, 1.5 in. broad. Inflorescence, few flowered, axillary panicles of white flowers with prominent yellow anthers. Flowers 0.4 in. across ; stalk 0.2 in. long, angled, densely stellate-pubescent. Calyx 5 valvate sepals united at the base ; sepals lanceolate, margins entire, apex obtuse, densely stellate-pubescent 0.16 in. long, 0.04 in. broad, valvate. Petals 5 elliptical, imbricate, 0.3 in. long, 0.2 in. broad, with prominent midribs ; glabrous on both surfaces except for a breadth of 0.04 in. from the margin on the outer surface where it is pubescent. Stamens 15 in 2 rows, the outer shorter ; anthers introrse, dehiscing laterally ; connective prolonged to an obtuse apiculus : external valves of anther the larger. Filament

slender, about 0.2 in.; anther 0.06 in long ; apiculus 0.04 in. long. Ovary hemispherical, densely tomentose, Style 0.2 in. long, angular, pubescent. Fruit spherical, densely tomentose, with reflexed, enlarged, adnate sepals.

Endemic. Hunuwal Kande near Pelmadulla, F. Lewis.

The following note appears in Trimen, Fl. Ceylon, V (1900), 384, " it is evident that, if this species is to be retained in the genus *Stemonoporus*, the generic character of the latter must be modified to include a plant with a long subulate process terminating the anther."

Thwaites, in Hooker's Kew Journ. Bot., VI (1854), 67, defined the genus *Stemonoporus* thus :— " Char. gen. Calyx 5-partitus, laciniis aequalibus *fructiferis vix auctis*. Corollae petala 5, aequalia, aestivatione convolutiva, stamina 15, biseriata (5 interna, 10 externa), *monadelpha* ; filamenta in annulum brevem, ovarium cingentem, coalita ; antherae oblongae, introrsae, *singulae poro terminali dehiscentes, connectivo non producto*. Ovarium 3-loculare ; etc."

Our species has (1) a calyx enlarged in the fruit, (2) stamens which are not monadelphous, (3) anthers which dehisce laterally, (4) connective prolonged to an apiculus. Brandis (*op. cit*), in his key, p. 3, based on a comparison of 13 other species of *Stemonoporus* with the several species of *Vatica*, distinguished between the tribes *Vaticeae* and *Vatericae* (to which *Stemonoporus* belongs) in that the former has a valvate calyx, and the latter an imbricate calyx. Our species which has a valvate calyx comes under the former tribe, and agrees with the characters enumerated there under *Vatica*, viz, " Lobes of fruiting calyx equal ; 2 wings in some cases ; anthers short, oval, glabrous ; appendage obtuse." As the lobes of the fruiting calyx are equal, are shorter than the fruit, and are spreading or reflexed in our species, it should be placed under the sub-genus *Retinodendron*.

Stemonoporus revolutus Trimen Mss., Hooker's Trimen Fl. Ceylon, V (1900), 384.

A tree, " branches robust, covered with iron grey bark ; leaves crowded, imbricating towards the end of the branchlets, 0. 5-2 in. long, 1-1.5 in. broad, obovate or obovate-oblong, tip rounded, emarginate or retuse ; base rounded, rigidly coriaceous ; sides revolute when dry, quite entire, smooth above with obscure midrib and veins, beneath pale with a prominent midrib and 7-10 pairs of spreading arched, slender veins venules minutely reticulate ; petiole 0. 3-0.5 in. long, stout. Stipules 0 " (Trimen). Leaves gland-dotted on lower surface. Flowers 0.5 in. across, 1 in. long, 3 or more on long, axillary, slender, rough cymes. Pedicel about 0.25 in. long, rough, green. Sepals 5, reddish-green, oblong-lanceolate, apex acute, margins entire, glabrous on both surfaces,

Petals 5, yellowish-green, imbricating, oval, apex acute, margins entire both surfaces glabrous. Stamens 15, almost sessile, united at their bases into a ring surrounding the ovary ; connective not prolonged ; anthers opening by a terminal pore. Ovary slightly silky pubescent. Style 0.08 in. long. Fruit brownish, surrounded at base by enlarged sepals ; exalbuminous ; cotyledons ruminate.

Endemic. Walankande, Panilla.

In Hooker's Trimen's Fl. Ceylon, V (1900), 384, the following note appears under *S. revolutus* Trim. " The specimens having neither flower nor fruit, the genus is doubtful." It is strange that these flowers and fruits which have been in the herbarium since 1893 were overlooked.

In view of the economic possibilities of this order, owing to the valuable timber and resin which some of the species yield, and in view of the confusion which prevails as to the identity of the several species, a number of them being still undetermined, the writer hopes to go into the subject more fully. *Vatica Roxburghiana* Bl., which according to Mendis (2) yields the best kind of wood for underground purposes, *Vateria acuminata* Hayne, " which exudes a clear yellowish resin abundantly, equal to the best Dammar," and the fruit of which is eaten, are examples of the utility of some species. Several species are also suitable as ornamental shade trees. *Vatica obscura* Trimen, a gregarious, dry zone species, with a hard, heavy, brown wood, and pinkish-white, rather pleasant smelling flowers, and affording an odorous sticky gum resin, makes a good shade tree for Colombo or Kandy, as it does not shed all its leaves periodically and as it permits itself to be grown so as to reach any desired height and to give the required amount of shade. This is only one of the many opportunities of combining utility with ornament.

Instances of confusion of species are very common, being largely due to the fact that several members of this order, even though they belong to different genera, have the same Sinhalese name. Mendis (*op. cit.*) p. 11, says of *Doona zeylanica* Thw., " several varieties as regards the colour or value of the timber, such as sapu-doon, etc. are known in Hewahette at least, if they are not the Sinhalese names of some of the following or other species."

In conclusion my most sincere thanks and gratitude are due to Mr. T. Petch, the Government Botanist and Mycologist, for his kindness, advice, and many helpful suggestions during the progress of my work.

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EXPLANATION OF PLATE XI.

A. *Hopea cordifolia* Trimen. 1, Flower. 2, Stamens. 3, Sepal which enlarges to form wings. 4, Sepal which does not enlarge to form wings.

B. *Isoptera lissophylla* (Thw.) Livera. 1, Flower before opening 2, Flower after opening. 3, Stamens. outer and inner view of of anthers showing prolonged bearded connective. 4, Fruit.

C. *Vatica Lewisiana* (Trimen) Livera. 1, Flower. 2, Same with corolla removed. 3, Stamens showing prolonged blunt connective and lateral dehiscence of anthers. 4, Fruit.

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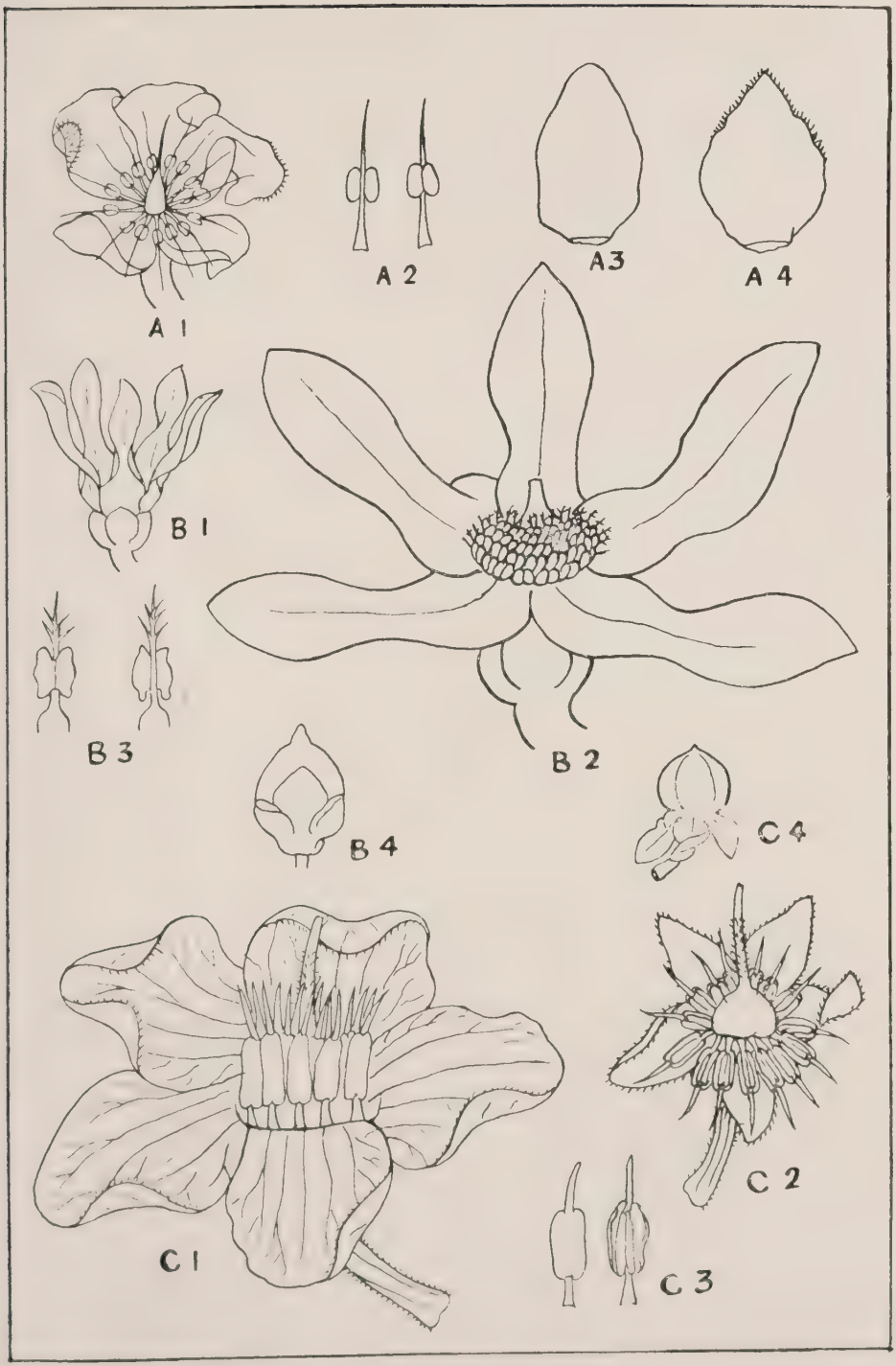
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Gregarious Flowering.

BY

T. Petch, B.A., B.Sc.

In the "American Journal of Botany" for February, 1923, W. Seifriz has discussed the possible causes of gregarious flowering in plants, among others the bamboos and the Talipot palm.

After noting that Garner and Allard were able, by controlling the time of exposure to light, to cause the field aster, which commonly requires four months to reach sexual maturity, to bear flowers within a month after germination, he points out that the problem of determining the environmental factors which influence the flowering of plants assumes a special interest when considered in reference to those plants which flower only after a period of many years of purely vegetative growth, and becomes particularly interesting when applied to those plants in which all the individuals of a species throughout a given region attain sexual maturity simultaneously.

The theoretical aspects of the problem with regard to biological characters which have hitherto been considered fixed, and the possible effect of environmental factors upon such characters, have been fully discussed by Seifriz. Botanists in the tropics will no doubt agree with his conclusions that at present the theory that gregarious flowering is determined by a germinal factor is without disproof, and that the flowering of bamboos, etc., is not directly induced by preceding or current climatic conditions. But it is only too evident from his paper that the available data are inadequate to afford a foundation for a definite conclusion ; while in some instances they are incorrect.

The acquisition of valid data on this subject is not a light task. The plants in question flower at long intervals, and in some instances no botanist can reasonably expect to observe the full course of two successive generations of the same strain in a life time. Perhaps for that reason no one has thought it worth while to begin accurate observations. Hence, except possibly in the case of some of the Indian bamboos which are under the supervision of a Forest Department, the available data consist largely of general impressions, depending as a rule on memory, or on the inherited recollections of two or three individuals.

It might be expected that, as botanic gardens have been in existence in the tropics for more than a hundred years, they would be able to furnish definite information in respect of many plants. But the realisation of the importance, from a scientific point of view, of keeping accurate records of the operations and events of a botanic garden is of recent date. Half a century ago, the fact that a plant was established in the garden was no doubt considered sufficient. It could scarcely have been foreseen that the date of planting of a particular specimen would be of interest to another generation. Such facts might be remembered by the officer then in charge, but they were not put on record. Consequently, by the time the plant flowered, in the case of monocarpic species with a long life period, all evidence had disappeared owing to the death of the officer under whose direction it was planted.

It is obvious that continuous observations on these species cannot be carried to completion by an individual. The determination of the age at maturity is essentially work for a botanic garden, where it may be continued by a succession of officers in charge. If groups of plants were raised from seed with that definite object, properly labelled, and contemporaneous records filed, it should ultimately be possible to obtain exact information on points regarding which we have at present only recollections and obscured impressions.

Of course, if, as recommended by some, the history of every individual plant in a botanic garden were separately recorded, there would be no occasion for the procedure advocated in the foregoing paragraph. But such a scheme is generally impracticable. The attempt to avoid the Scylla of no records has, in one instance at least, by the invention of complicated schedules which no staff could possibly attend to, led directly to the Charybdis of again no records.

The present paper merely enumerates the data at present existent in Ceylon regarding the flowering of the Talipot, the Giant Bamboo, etc., with the object of placing on record what few facts are known.

THE TALIPOT PALM.

(*Corypha umbraculifera* L.)

In the case of this species, Seifriz discusses principally the flowering of the palms in the Talipot Avenue in the Peradeniya Gardens in 1918. He states "Ordinarily *Corypha umbraculifera* does not flower gregariously nor at a fixed age, as do certain bamboos. Consequently, when many specimens of the talipot palm do flower simultaneously, one is likely to suspect the presence of some external factor which has aroused the palms to sexual activity."

A botanist, resident in Ceylon, could not unreservedly agree with either of these premises. It is perhaps a matter of definition, but there are well-marked Talipot years, when large numbers flower simultaneously. The railway from Colombo, as it ascends the hills to Kandy, passes through the Talipot zone, and the sight of these magnificent palms, crowned by an inflorescence visible at a distance of several miles, has on various occasions incited a traveller to record the event in the local press. In that way we know that 1894 was a Talipot year, and also 1898. In the latter year, a passenger by train recorded that he counted 21 Talipots in flower between Rambukkana and Kadugannawa, a distance of 12 miles. In November, 1918, the writer, travelling over the same route, counted from the carriage window, 52 Talipots in flower between Alawwa and Peradeniya, a distance of 30 miles which includes the section referred to by the observer of 1898. In considering these numbers it must be borne in mind that the region in question is almost entirely under cultivation, and the Talipot palm is not of sufficient economic importance to make its preservation worth the villager's while.

As regards the Royal Botanic Gardens, Peradeniya, we have dates of flowering of two Talipots simultaneously in 1877, and single examples in 1887, 1890, 1898, 1903 and 1913, in addition to the flowering of the palms in the avenue in 1918. In two of these instances, i.e. 1898 and 1918, flowering in the Botanic Gardens is known to have coincided with a general flowering elsewhere, but for the other five instances we have no similar information. The Gardens were opened in 1822. The list of the trees then growing on the site makes no mention of Talipots, but it is possible that they might not have been considered of sufficient value to record.

Although I have not kept detailed records of the occurrence of Talipots in flower, I would summarise my experience in Ceylon during a period of eighteen years in the statement that there are certain years in which large numbers of Talipots bloom simultaneously, but there are few years (if any) in which a single Talipot cannot be found in flower somewhere in the Talipot zone.

The well-known Talipot avenue in the Peradeniya Gardens was planted by Trimen. In his diary for 1881 he recorded that 30 young plants (not seed *in situ*) had been planted out in June of that year, but to this entry he afterwards added the note, "nearly all subsequently died." In July, 1882, young palms were again planted, but there is no record of the number supplied or of the number of survivors from the previous year, while the diaries of the following years make no mention of further replacements, though it is clear that such did occur. It is most probable that the plants of 1881 and 1882 were in both cases the progeny of the palms which flowered in 1877.

In 1918, the avenue consisted of 20 palms. Two of these are small and were evidently planted during the present century. Of the remaining eighteen, seven flowered in 1918 and eight in 1922. Three old palms have not yet flowered ; these are smaller than those which have flowered, and were most probably planted to fill up gaps a few years subsequent to 1882.

Seifriz writes " The second objection to be raised against the conclusion that drought caused the flowering of the plants in the Peradeniya Gardens is that nine of the sixteen Talipot palms did *not* flower, and these nine were of the same age and had been growing under the same conditions as the seven which did flower." It will be evident from the foregoing paragraphs that Seifriz was not aware of the actual conditions. It is most probable that all the plants were of the same age from seed, but it is certain they were planted in different years. In that case, if they were of the same age from seed, the plants of 1882 remained in the nursery a year longer than the others, and it is probable that the prolonged stay in the nursery, and the transplanting at a later age, may have had some influence in delaying the age of maturity. Evidence bearing on this point is given below.

The evidence afforded by the flowering of the palms in the Talipot Avenue is insufficient to decide the question whether the offspring of one tree will flower at the same time if grown under the same conditions. It is not certain that the palms were grown from seed from the same tree, though it is very probable that they were grown from seed from trees of the same age (see below) which flowered at the same time ; but the young plants were not all grown under the same conditions throughout.

The same uncertainty attends the determination of the age at which the Talipot flowers. If we assume that those planted in 1881 all flowered in 1918, and those planted in 1882 all flowered in 1922, then these palms flowered at 37 and 40 years respectively from planting out. But the age of the young palms when planted out was not recorded. The Talipot grows slowly at first and it may be transplanted from the nursery at a comparatively late age. In the Report of the Royal Botanic Gardens, Peradeniya, for 1907, it is recorded that a row of Talipots had been planted out,—" the progeny of the palm which fruited in 1900," i.e. the one which began to flower in 1898. In the case of the Avenue palms, the probability is that the seeds were derived from the palms which flowered in 1877, and that they were planted in the nursery in 1879. On that supposition, the palms would be 39 and 43 years of age respectively, from seed, when they flowered. But it will be clear that the data lack the accuracy desirable in a scientific determination.

Two Talipot palms flowered simultaneously in the Palm Grove at

the entrance of the Botanic Gardens, Peradeniya, in 1877. Thwaites, in recording the event in his Annual Report for that year, wrote that they had proved glorious ornaments to the Garden for a period of nearly forty years. This palm grove was instituted by Lear in 1839, so that the age of the palms from planting out was at most 38 years, unless Lear planted his palm grove round two existing Talipots. One of these palms was felled, after flowering, in 1880 ; the other was left to decay, and collapsed in October, 1885.

Nothing definite is known about the age of the single trees which have flowered in the Gardens at various times. From their situation, it would appear that many of them were chance seedlings. When the Talipot fruits are ripe, they are carried off by the large fruit-eating bat (*Pteropus Edwardsii*), known in Ceylon as the flying fox, which drops the seed after gnawing off the outer rind. After a Talipot had flowered in 1903, thousands of seedlings sprang up in 1905 under the neighbouring *Ficus Trimeni* and other trees.

Trimen, in recording the flowering of a Talipot in 1887, wrote " The event is of more importance than usual, as, the age of the tree being pretty accurately known, a question often discussed is set at rest. The specimen is remembered well to have been a seedling of two or three years old when Mr. Gardner became Superintendent of the Gardens in 1843 ; it is therefore 46 or 47 years old." The evidence, however, cannot be accepted as reliable. Trimen's diary shows that his statement was based on the recollections of an old retired member of the Sinhalese staff, then about 90 years of age. Memories usually elongate with age, and in the tropics they are notoriously unreliable. It would be easy to confuse the arrival of Gardner in 1844 (not 1843) with that of Thwaites in 1849.

Seifriz remarks that " it would be interesting to know if the flowering of the Buitenzorg Talipot commenced in the same month, June, 1918, as did that of the Ceylon palms. That the palms in Ceylon and at Buitenzorg did flower at very nearly the same time of year is evident from the Peradeniya data and from my observations in Java." The Peradeniya report for 1918 states that the palms " commenced to flower in June, and continued in blossom until the end of the year being at their best in October - November." The record of the Talipot which flowered in 1913 states that it " commenced to flower early in July, 1913, the inflorescence reaching full development by the end of the year." The interpretation of these statements depends on the botanical meaning which is to be attached to the phrase " commenced to flower." Trimen's notes on the specimen which flowered in 1887 are as follows :—" August 4th, the Talipot in the paddock is pushing up its flowering head ; October 15th, the Talipot in paddock now in advanced bud and the inflorescence

feathery; November 25th, Talipot in paddock really in flower." The example of 1890 flowered on November 14th. The Talipot in Ceylon flowers in general from November to January, and the phrase "commenced to flower" no doubt means that the inflorescence began to appear, not that the flowers opened.

It has been customary for the Peradeniya Gardens to distribute seeds of the Talipot to Botanic Gardens in other countries whenever a palm fruited at Peradeniya. Consequently it is possible that the palm which flowered at Buitenzorg in 1918 may have been grown from seed of the palms which flowered at Peradeniya in 1877. Unfortunately we have no record of despatch of Talipot seeds prior to 1883. In that year, seeds were sent to Demarara, Jamaica, Brazil, Hongkong, Madras, Singapore, and Kew. In 1885, seeds were again sent to Demarara. In 1888, seeds were sent to Singapore, and in 1889 to Buitenzorg, Fiji, Florida, Trinidad, and British Guiana. In 1891, seeds were sent to Singapore, Calcutta, Jamaica, and Trinidad.

In 1905, a self-sown seedling sprang up at the base of the palm which flowered in 1903. The latter was the tree, the photograph of which is reproduced by Seifriz on Plate XII, fig. 2. It was in contact with the base of the old stem, and consequently was left unmolested by the weeders and the grass-cutting coolies. It stands practically on the same spot as the parent tree, near the Head Office (the old Museum), and is now a well-grown palm. Thus the age of this tree from seed is definitely known.

The age of the palms planted in a row in the Botanic Gardens in 1907, along the short incline from the Orchid House towards the river, is also definitely known. The seed was obtained in 1900 from the palm which flowered in 1898. But the growth of these is very backward. Three of them, at the foot of the slope, are just (1923) showing a stem, but the others do not yet show any indication of a stem. On the other hand, the self-sown seedling from the palm which flowered in 1903, although it stands on the top of a hill, has a stem ten or twelve feet high. The latter palm is five years younger from seed than those in the row, but in point of development it is at least five years ahead of the best of them.

The foregoing examples support the view that the growth of the Talipot is retarded if the young plants remain for a long time in the nursery. The probable explanation of the fact that seven palms flowered in the Talipot Avenue in 1918, while eight did not flower until 1922, is that the plants were raised from seed which was all sown in the nursery at the same time, but the second group was planted out a year later than the first.

The further development of these trees should prove of great interest. If the Talipot were a strictly gregarious flowerer, all the palms in the row referred to should bloom at the same time, regardless of their size. That scarcely seems probable. I have never seen a dwarf Talipot in flower. Again, if the Talipot flowers at a fixed age, those in the row should flower before the single specimen near the Head Office,—which seems still more improbable.

On the other hand, the palms in the row have been subjected to an unnatural treatment and they are not comparable with palms in a wild state, grown from seed *in situ*. Judging from the size of wild palms at the time of flowering, it is to be expected that the palms in this row will flower at widely different ages. That, of course, remains to be seen, but should it happen, then the Talipot is not strictly a gregarious flowerer.

The fact that large numbers of Talipots of about the same size flower simultaneously indicates that, under favourable or normal conditions, the Talipot blooms at a fixed age. But it would appear probable, from the behaviour of the young palms grown in the Botanic Gardens, that the age at flowering may be greatly increased by unfavourable conditions for growth when the palms are young.

The view that the flowering of the Talipot is induced by a period of drought is not supported by the records of flowering at Peradeniya.

It might perhaps be expected that when the life period of a monocarpic plant is a very long one, this character would, as in the case of morphological characters, be subject to some variation. It is conceivable that, while the majority of the offspring of a plant which flowered and died at the age of forty years might have a life period identical with that of the parent, some might depart from this by a few years on either side of the mean. In that way it might be possible to account for the blossoming of a few plants in the intervening years. It is not, however, evident why there should have been a marked Talipot year in 1898, i.e., at about the middle of the life period of the palms which flowered in 1918. This is paralleled by the behaviour of *Strobilanthes sexennis*. The latter plant flowers and dies at intervals of twelve years. But there are adjacent areas of this plant, the flowering times of which differ by five (or seven) years, i.e., one area flowers and dies about the middle of the vegetative period of the adjacent area.

THE GIANT BAMBOO.

(*Dendrocalamus giganteus* Munro).

The Giant Bamboo was introduced into the Calcutta Botanic Gardens in 1831, and from there a plant was received at Peradeniya in 1856. From the latter, numerous plants were propagated vegetatively, and set out

in the Botanic Gardens, Peradeniya, or distributed to other parts of Ceylon.

Trimen, writing in 1881, stated that no specimen had as yet flowered in Ceylon, but that the plant had flowered at Calcutta in 1861 or 1864 and had survived. In a letter written in 1892, he placed the date of flowering at Calcutta as 1861, and added that the plant, though weakened, did not die.

The earliest indisputable date of the flowering of the Giant Bamboo in Ceylon is 1892 (not 1886), when a plant flowered at Abbotsford, at an elevation of 4460 feet. This plant had been obtained from Peradeniya in 1874, so that the actual plant was eighteen years old at the time of flowering. But it had been propagated vegetatively from the plant introduced into Ceylon in 1856, and the latter had been similarly propagated from the Calcutta plant of 1831. Thus the age of this plant from seed was at least 61 years.

Only a few stems flowered in 1892 at Abbotsford in a clump of about one hundred. Specimens were submitted to Trimen and the identity of the species verified. Macmillan in 1908, recorded, on the authority of the then manager of Abbotsford, that this clump was still alive and " in a condition of mixed flowering."

Trimen, in his letter referring to the above-mentioned occurrence, stated that he had been informed that a clump at Nawalapitiya (1900 feet) had flowered five years previously, but he did not get an opportunity of seeing it. The record is consequently doubtful. In spite of the apparent uniqueness of the Giant Bamboo, it is easy for the non-botanist to mistake other species, e.g., *Gigantochloa aspera*, for it.

The clumps in the Botanic Gardens began to flower in 1903, eleven years after the plant at Abbotsford. One clump bore flowers on sixteen stems out of about four hundred, but none of the other clumps flowered in that year (Annual Report, 1903). Subsequently other clumps flowered profusely, and in 1906-1908, these flowering clumps were conspicuous (and unsightly) objects in the Gardens. The Report for 1907 stated that most of the clumps had been in an irregular condition of flowering for the last three years, while the Report for 1909 stated that only one clump had died out up to that date.

The behaviour of the Giant Bamboo on flowering at Peradeniya may fall into any one of the following categories :—

(1) All, or nearly all, the culms produce flowers and the plant dies.
(2) Nearly all the culms flower, but new vegetative culms spring up at one side of the old clump, and on the death of the flowering part of the latter, the new culms form another compact clump.

(3) The majority of the culms flower and die, but new culms are produced irregularly round the mass of decaying stumps. These new culms may flower or not. In some cases, the non-flowering culms predominate after a few years. Such clumps usually produce, in addition to the normal culms, numerous slender stems, six to twelve feet high, which have the appearance of a different bamboo growing in the old clump. These slender stems may flower or may bear leaves only.

Of the seventeen old clumps in the Botanic Gardens, known to me in 1905, four have flowered and died.

One clump, which stood between the lake and the river, flowered about 1907 and the whole of the old clump ultimately died. But before that happened a few new culms sprang up at one side of it, and these now form a compact clump, without any flowering stems.

Four other clumps have flowered, but have not died, though some of them began to flower before 1910. The old culms which flowered have died, but new culms, some flowering and others vegetative, are still being produced round the decaying mass of roots and stumps. They are not all in the same condition. One consists of a large mound of decaying stumps, with comparatively few new culms of medium size ; it is still producing new culms, but will probably die. The others are not so dilapidated, and the new culms are normal and vigorous. One of these is now in a better condition than it was in 1910, shortly after it began to flower. The new culms tend to be grouped in small clusters, which are probably growing independently. All these are in the condition described as " mixed flowering " in the case of the Abbotsford specimen.

The largest clump in the gardens, standing near the east side of the lake, is just beginning to flower. In 1923, a few culms on one side were in flower, but they were not sufficiently numerous to affect the appearance of the clump.

Seven old clumps have not yet flowered.

The statement in the Annual Report of the Botanic Gardens for 1918, that the flowering of the Giant Bamboo in Ceylon is not now the rare event it used to be, no doubt refers principally to the clumps which have been in a condition of partial flowering for many years, in one case at least fifteen.

It is to be noted that *Fomes lignosus*, one of the common root disease fungi of the tropics, frequently grows on decaying bamboo stumps, and it is probable that in some cases this fungus may cause the death of a clump after flowering.

Clumps may also die before flowering, probably from disease. In

the Annual Report of the Royal Botanic Gardens, Peradeniya, for 1891, Trimen recorded that two or three of the clumps of the Giant Bamboo in the Gardens had died during the year without apparent cause.

As far as Ceylon experience shows, it may be said that (1) The Giant Bamboo does not flower gregariously ; (2) it does not necessarily die after flowering ; (3) clumps may produce both flowering and foliage shoots for a period of at least fifteen years ; (4) a clump which has flowered may subsequently produce only vegetative culms.

BAUHINIA ANGUINA ROXB.

As tending to indicate that the flowering of the Talipots at Peradeniya in 1918 was due to some abnormal climatic conditions, reference has been made to the fact that *Bauhinia anguina*, which had never been known to flower previously in Ceylon, bore fruit in that year. This occurrence requires a more detailed record to prevent erroneous deductions.

A plant which is presumed to be *Bauhinia anguina* has been grown in the Botanic Gardens, Peradeniya, since before 1824. About the year 1860, it covered the pillars of the entrance gate of the Gardens ; and until a few years ago an enormous example arched over the Liane Drive and hung from an adjacent *Ficus elastica*. There is little doubt that the plant is not native to Ceylon. Trimen found it growing at Doluwe-kande apparently wild. But, because of the shape of the stem, it has a reputation as a snake charm and is known as Naga-darana (the track of a snake). Consequently, W. Ferguson suggested that it was probable that the plant had been taken to Doluwe-kande by plumbago miners.

In the Report of the Royal Botanic Gardens for 1918 it is recorded that *Bauhinia anguina* fruited in that year for the first time on record at Peradeniya. This was also the first record of its flowering in Ceylon. But the old plant did not flower. A plant had been propagated vegetatively from the old plant, and established in its proper position in the Arboretum. It was this plant which flowered. Incidentally, it may be noted that the actual flowering was not observed, a single fruit being found on the plant subsequently. Consequently, the identification of this plant remains unconfirmed.

STROBILANTHES.

The best examples of gregarious flowering in Ceylon are afforded by the various species of *Strobilanthes* which cover large tracts in the hill country. These *Strobilanthes* are collectively known as Nilu, Nillu, or Nilloo (Sinhalese Nelu), and their flowering usually attracts attention not only because the sight of a large number of plants massed together in flower at the same time is unusual in Ceylon, but also because when the

Nilu has flowered large numbers of jungle fowl congregate to feed on the seeds and furnish an easy prey for the local sportsmen. Nevertheless, exact data regarding the flowering of the different species have not yet been secured.

Twenty-eight species of *Strobilanthes* have been recorded for Ceylon, and there are probably more. The gregarious up-country species are *S. viscosus* And., *S. Walkeri* Arn., *S. anceps* Nees, *S. asperrimus* Nees, *S. vestitus* Nees, *S. Hookeri* Nees, *S. calycinus* Nees, *S. laxus* And., *S. sexennis* Nees, and *S. pulcherrimus* And. But the name Nilu may be applied to any gregarious Acanthad. H. P. C. Armitage, in the Ceylon Observer of May 3, 1899, described the flowering of the " Nilu " of the Vavuniya district (Dry low-country zone) : the plant was *Stenosiphonium Russellianum* Nees, for which the Sinhalese name is Bu-nelu. The latter plant has the same status in the dry low-country forests, as *Strobilanthes* in the up-country jungles, but, *fide* Armitage, it is biennial.

Trimen (Flora of Ceylon, III, p. 229) referred to these species of *Strobilanthes* as follows,—

" Many of the species which grow in the upper montane zone are remarkable for their gregarious occurrence in vast abundance and over large areas. The principal ones, especially common, and, together or separately, forming unbroken sheets of undergrowth in the forests are *S. viscosus*, *asperrimus*, *calycinus* and *sexennis*, to which may be added less commonly *S. Walkeri*, *anceps*, *Arnottianus*, *vestitus*, *Hookeri*, *laxus*, *pulcherrimus*, and a few others. These live for several years without flowering, growing close together with straight erect stems, which in some reach a height of 8-10 feet, are quite woody, and several inches in diameter. A few flowers may here and there be found every year, but it is not until the plants reach a certain age, apparently usually from 10-13 years, that the whole patch or area bursts into simultaneous blossoming. These patches or districts are often of great extent, and the boundaries between those of different ages are very conspicuous, being as distinct as if artificially sown. After this general and profuse flowering the whole patch begins to wither and ripen the seed—a process which takes several months or even a year (whence ripe seed is rarely found in herbariums), and then dies down. There is probably a patch to be found flowering somewhere in the mountains every year."

As Trimen stated, his information concerning the flowering of the Nillu was derived principally from Mr. T. Farr, who had resided for many years up-country and, as a sportsman and naturalist, had made observations on this subject. It must be borne in mind, however, that these observations are general, and liable to be incorrect as regards species.

Trimen recorded that roots of *Strobilanthes stenodon* Clarke, brought

from Ritigala in 1887 and planted in the Botanic Gardens, Peradeniya, did not flower until 1893 and then died. The period of this species is consequently greater than six years.

Strobilanthes sexennis was so named from an erroneous observation of Walker's, that the plant flowers in its sixth year. Trimen quotes Farr to the effect that great flowering of this as of several other species does not occur sooner than the eleventh or twelfth year. This species is the largest and commonest of the Nillus of the hill forests. It becomes a small tree, up to 12 feet high, with a stem 4-5 inches in diameter.

Of *Strobilanthes pulcherrimus* And., Trimen stated, " This is too striking a plant to be overlooked when in flower, and it is pretty certain that there was no general flowering between the seasons 1881-2 and 1893-4."

Farr, writing in the local press in 1899, stated that he had seen the Nillu flower in different districts many times ; in 1870, 1882, and 1894 all in the same Nillu district ; in 1875, 1887, and 1889, all in the same Nillu district. He added that there were other flowerings in other districts, and, as far as his experience of 29 years went, the interval between each flowering in each " district " was 12 years.

The term " district," as employed by Farr, means a continuous area covered by *Strobilanthes* which will flower at the same time. His " districts " are not necessarily different geographical districts, such as two different valleys, or even two districts different climatically, but merely two different areas of *Strobilanthes*, whether adjacent or widely separated.

Farr's statements having aroused some criticism, in which the flowering of the Nillu was attributed to climatic conditions, he emphasised and extended them in the following further communication.

" When I wrote to you on the subject of Nillu flowering in Ceylon, I was writing from notes I had made in my " sporting diaries " during the past twenty-nine years.

" Mr. J. Fraser of Abbotsford has ventured to doubt the correctness of my statements and has endeavoured to put me right. He has apparently failed to grasp my application of the term district. I do not refer to a tea or coffee district, but to a Nillu district ; and if Mr. Fraser would care to see the boundary of two such districts he can do so the next time he ascends Totapala on his way to fish on the Horton Plains, just above the old ela. The boundary is straight and perfectly distinct. On the Ambawela side, the Nillu, chiefly *Strobilanthes pulcherrimus*, *S. sexennis*, *S. calycinus*, and *S. viscosus*, is now in seed ; it flowered (generally) from August to December last year, 1898 ; it last flowered in 1886. On the Horton Plains side of the boundary I describe, the Nillu

is now from four to seven feet high ; it flowered in 1893 and seeded and died in 1894 ; it will flower again generally in A. D. 1905, Mr. J. Fraser and his dry cycles to the contrary notwithstanding.

" Some of the Nillus, of which there are over thirty different kinds in the island, I believe, are to be found in flower every year, especially *S. viscosus*, but not followed by universal death. Again, during the year preceding the big and universal flowering many plants throw out a spray or two of flower, especially by the sides of roads and notably *S. pulcherrimus* ; but this spasmodic flowering is not followed by death, I think.

" If Mr. Fraser wants to see another Nillu district boundary, let him walk up from Elgin to the Elk Plains *via* the Rajahpatanas, and another between the Horton Plains and North Cove Estate. I know of many more of them.

" I have in my possession notes of the flowerings of Nillu giving dates as follows :—1851, 1857, 1862, 1868, 1873, 1881, 1882, 1886, 1888, 1893, 1894, 1898-, the first five obtained from the late Dr. Trimen when in correspondence with him upon this subject in 1893. These dates were taken from dried specimens in his possession. By the dates I can trace back a good many of the Nillu districts I know, " duodecennially," if that is the correct term.

" Some of these specimens may possibly have been collected in the year preceding the universal flowering. An unusually dry season would probably induce more blossom among the Nillus than a wet one, in the the year preceding its general flowering."

The largest Ceylon *Strobilanthes*, and the one which, in general, forms the predominant part of the undergrowth in the *Strobilanthes* areas of up-country jungles, is *Strobilanthes sexennis*. It is when this species flowers, that the general Nillu flowering is noticeable ; and when it dies in consequence of flowering, the dead stems, covering areas extending for miles, are an equally conspicuous feature of the landscape. The smaller species, *S. pulcherrimus*, *S. calycinus*, *S. anceps*, and others, flower and die at the same time on the same areas, but there would appear to be just a possibility that these species may die at other times, and that their death may pass unnoticed as they are more or less hidden from view by the dominant *S. sexennis*. That, however, is merely a suggestion for future observers.

In giving dates for the flowering of *Strobilanthes*, it is necessary to cite two successive years for each flowering. In these cases of gregarious flowering, the plants, in general, flower during the North East Monsoon in up-country districts ; and the flowering period, beginning in August-October, may extend into the following year, the plants being dead before the next September.

Confining attention to *Strobilanthes sexennis*, we have the following data. In 1922-23, this species flowered and died on the Horton Plains, on one area at Hakgala, on the Elephant Plains, in the jungle from Nanuoya to Single Tree Hill, and on Pedrotalagalla on the area traversed by the path to the peak. These areas extend over a distance of eighteen miles. In 1910-11, the same area of *Strobilanthes sexennis* flowered and died at Hakgala, but no records are available for the other localities. Farr recorded the flowering and death of this species on one area in the Horton Plains district in 1898-99, and in 1886-87.

Another area of *Strobilanthes sexennis*, near the summit of the Hakgala Peak, flowered in 1917-18. *S. sexennis* flowered at Nuwara Eliya in the same year. The Hakgala area flowered previously in 1905-06, and at the same time there was a general flowering on the Horton Plains probably in the second of Farr's districts, as predicted by him six years before. The previous date given by Farr for this area is 1893-4. Nock also noted *S. sexennis* in flower both on the Horton Plains and at Nuwara Eliya in 1893.

We can probably trace the flowering of this second area at Hakgala further back by the fact that *Campbellia aurantiaca*, a root parasite of *Strobilanthes sexennis* in Ceylon, which has only been collected recently when the *Strobilanthes* flowered, was collected at Hakgala in 1881 and in 1869.

The dates show that there is an area of *Strobilanthes sexennis* at Nuwara Eliya which flowers and dies at the same time as areas of the same species at Hakgala and on the Horton Plains, the interval between successive flowerings being twelve years. There are also other areas of the same species at Nuwara Eliya, Hakgala, and on the Horton Plains, which flower and die simultaneously, the interval between successive flowerings being again twelve years. But there is an interval of five (or seven) years between the times of general flowering and death of the two series.

The one series runs 1917-18, 1905-06, 1893-94, 1881-82, 1869-70, 1857-58; the other, 1922-23, 1910-11, 1898-99, 1886-87, 1874-75, (1862-63), 1850-51.

The localities and dates on the Peradeniya herbarium specimens of *Strobilanthes sexennis* are Adam's Peak and Ramboda, 1851; Dimbula, April, 1852; Nuwara Eliya, 1853; locality indecipherable, 1857; between Ramboda and Maturatta, January 1859; between the Elk Plains and the Horton Plains, February, 1882; Abbotsford Dimbula, August 1885; Horton Plains, November, 1893; Horton Plains (Maha Ellia road), January, 1906; Horton Plains, jungle path, January, 1906; jungle above Hakgala, April, 1906, November, 1906.

The specimens, Hakgala and the Hortons, 1906, 1893, and 1882, fit in the first series. The specimen from an indecipherable locality falls in the same series. Nuwara Eliya, 1853, does not fit in with either of the known Nuwara Eliya series. Adam's Peak and Ramboda, 1851, fits in the second series. The Dimbula specimens, and those from between Ramboda and Maturatta, are from other districts than those covered by the two series which have been determined. The two Dimbula specimens are not concordant with one another. The flowering date, August, 1885, if it refers to a general flowering, should be 1885-86, while April, 1852, should refer to a general flowering 1851-52.

Of the dates given by Farr, omitting those from herbarium specimens, 1869-70, 1881-82, 1893-94, fall in with the series 1905-06, and 1917-18. 1874-75, 1886-87 and 1898-99 similarly fit in with the recorded dates 1910-11, and 1922-23. The only discordant date is 1888, and it is possible that this may refer to another series in a different district ; it fits in with the Dimbula date 1851-52.

The area of *Strobilanthes* at Nuwara Eliya which flowered in 1922-23 was not examined until September of the latter year, and it was then possible to identify only *S. sexennis*. In the area which flowered at Hakgala during that period, *S. pulcherrimus* grew together with *S. sexennis* and flowered and died at the same time. On the Horton Plains in November, 1893, *S. sexennis*, *S. pulcherrimus*, *S. viscosus*, *S. calycinus*, *S. anceps*, and *S. vestitus* were in flower at the same time ; and at Nuwara Eliya in August of the same year, *S. sexennis*, *S. anceps*, and *S. asperrimus*. In 1917-18, *S. sexennis*, *S. calycinus*, *S. anceps*, *S. Hookeri*, *S. vestitus*, and *S. viscosus* were in flower at Nuwara Eliya.

In December 1913, a few stunted plants of a *Strobilanthes*, about two feet in height, were found in flower on the hill side (Hantane) above Peradeniya. They were growing on a piece of waste ground by the side of a road and had evidently been cut down on one or more occasions. It is probable that they had originated from seed washed down by an adjacent stream from the jungle on the top of Hantane. These plants were thought to be one of the rarer Ceylon species, and consequently seed was gathered in March, 1914, and sown in pots, and the seedlings planted out in the Botanic Gardens, Peradeniya, towards the end of the year. They did not flower until October 1921, by which time they had formed a tangled clump, about 10 yards long and 5 yards wide, rising to a height of 10 feet. There was no sporadic flowering previous to the general flowering of the whole mass, and all the plants died after ripening seed. Unfortunately the species proved to be merely *Strobilanthes viscosus*.

Thus, at Peradeniya, *Strobilanthes viscosus* in this instance flowered at the age of seven and a half years from seed, i.e., the interval between successive flowerings was eight years. There was no annual flowering, and no flowering in the year previous to the general flowering as claimed by Farr for this species.

At the end of 1921 and the beginning of 1922, *Strobilanthes Walkeri* was in flower by the stepping stones in the southern boundary ravine on the Hakgala reserve. From the jungle on the Hakgala hill, several ravines run down across the patana (grass land), each serving as a channel for a small stream which drains the forest above. These ravines are densely crowded with trees and shrubs, and form so many belts of jungle running straight down the hill side. In February, 1922, when collecting in the southern ravine, where the shade is so dense that the ground flora is almost limited to ferns, I gathered a specimen of a *Strobilanthes*, only about 7 inches high, but in flower. This proved on examination to be *S. Walkeri*. The stunted plant under dense shade had flowered at the same time as its normal relatives, about 6 feet high, in the open space by the side of the stream, being, in all probability, of the same age as the latter. This incident goes to prove that *S. Walkeri* is strictly a gregarious flowerer, all plants of a given patch flowering at the same time, whatever their size.

Some of the difficulties attendant upon the determination of the age of a particular species of *Strobilanthes* at flowering will be evident from the foregoing records. It is not sufficient to know that the species flowered in a certain year in a given district, e.g., the Nuwara Eliya jungles, as there may be more than one patch of that species in that geographical district. It is necessary to observe the flowering of one particular patch, definitely marked down without a possibility of error.

Again, several species of *Strobilanthes* may grow together, and it is possible that these may flower at different ages. Consequently, an exact determination of each species in flower is essential, not a general impression of the whole mass. Farr cited *S. sexennis*, *S. pulcherrimus*, *S. calycinus*, and *S. viscosus* as flowering simultaneously at intervals of twelve years. But at Peradeniya (1600 feet), *S. viscosus* flowered at an interval of eight years, while at Hakgala (6000 feet), *S. sexennis* flowered at an interval of twelve years. It is possible that the age at flowering may be modified by the elevation, but on the data available the period of *S. viscosus* is shorter than that of *S. sexennis*.

Observations are also required to check the statement that a few flowers are produced in years prior to the general flowering. This is at variance with the observations made on *S. viscosus* at Peradeniya, but the latter plants were only few in number. They were, however

allowed to run wild, that is, they did not receive any cultivation, pruning, or weeding after being planted out. It would seem possible that the statement in question may have been based on the flowering of different species in different years, the rarer species earlier than the rest.

To the foregoing difficulties must be added that few people now remain long enough in one locality in Ceylon to carry on continuous observations which may have to be extended over a period of twelve years before the first step is reached, even if one is able to start from the observed death of a *Strobilanthes* patch. The necessary observations can, however, be easily carried out in connection with a Botanic Garden in a hill station, and it is hoped that this will be undertaken at Hakgala.

As *Strobilanthes* tracts, composed of the same species but flowering at different times, may exist side by side, it would appear that the flowering of these *Strobilanthes* is not dependent upon climatic conditions.

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288.—Peniophora Habgallae (B. & Br.) Cooke.

Berkeley and Broome described this species in Fungi of Ceylon, No. 645, as *Corticium Habgallae*, "suborbiculare ceraceum ochroleucum, margine tenui tomentoso uno latere elevato ; hymenio subtiliter setuloso (No. 339). On dead bark. Habgalla." Cooke, in Grevillea, VIII, p. 20, transferred it to *Peniophora*, stating that the cystidia (metuloids) were narrowly fusiform, attenuated and smooth above, 70-80 × 12·5μ. Massee, in Jour. Linn. Soc., XXV, p. 142, repeated Berkeley and Broome's description, adding that the cystidia were fusoid, 60-70 × 12μ, and the spores subglobose, 5-6μ. Massee stated that the fungus formed "more or less elliptical patches about 1 in. long by ½ in. wide, and in every instance with a tendency to become reflexed on one side, thus forming a transition from the truly resupinate to the reflexed species." The name of the locality should have been Hakgala.

The fungus is common at Hakgala on dead branches of *Cinnamomum Camphora*. It is pezizoid, circular or oval, regular or somewhat lobed, up to 1·5 cm. diameter. The upper surface is plane or undulating, with a sharp definite margin, from which the convex sides curve backwards slightly into the flat base, which is attached to the host plant only over a central area. When fresh, the fungus is up to 3 mm. thick, but it contracts to a disc, 0·5-1 mm. thick, on drying. The fresh specimens are fragile, with a fleshy cortex and hymenial layer, but subgelatinous internally ; the colour of the hymenium is white, or pallid with a white margin, while the lower surface is white. The hymenial layer is about 0·15 mm. thick, and the cortex at the base and sides 0·1 mm. thick. The cystidia are hyaline, flask-shaped or conical, encrusted, wall slightly thickened, 80-100 μ high, 14-20 μ diameter below. The spores are oval, smooth, hyaline, 16-21 × 12-14 μ. The lower surface is slightly tomentose towards the margin, and it becomes concentrically grooved in drying.

The "uno latere elevato" of the original description was probably an accident of growth, or a distortion in drying.

289.—Kneiffia gelatinosa B. & C.

This was described by Berkeley in Cuban Fungi, No. 363, as "Effusa, arctissime adherens, venosa, gelatinosa, pallida, papillis minutis farinosa. Resembling *Phlebia* in habit ; but the minute papillae, which have frequently little setiform appendages at their apices, bring it under *Kneiffia*. It may perhaps form a distinct genus, when *Hydnum gelatinosum* is separated." In Fungi of Ceylon, No. 569, Berkeley and Broome recorded the same species from Ceylon. Patouillard, Bull. Soc. Myc. France, VIII, p. 120, transferred it to *Heterochaete*, stating that the basidia

were claviform, 30×15 μ, two to four septate, the spores elongated oval, 20-25×8-10 μ, the promycelium short, 10-15 μ, and the conidia subglobose, 10 μ.

The Ceylon specimen, Thwaites 602, is resupinate, livid grey, horny, about 0·1 mm. thick, covered with short processes, which are conical, or cylindric, sometimes expanding above, sometimes flat topped, up to 0·1 mm. high and 50 to 150 μ diameter at the base. It is compact, with a thin yellow-brown basal layer, the remainder being hyaline and translucent, containing numerous, large, irregularly oval masses of calcium oxalate, up to 24×20 μ. The hymenium is continuous over the processes, and contains conical, hyaline, encrusted cystidia, 24-30 μ high, 8-10 μ diameter, projecting 16 to 20 μ, which are scattered over the flat surface, but clustered on the apices of the processes. The basidia are cylindric, 4 μ, diameter, with four short sterigmata.

The Ceylon species is not *Heterochaete*. The cystidia are those of a *Peniophora*, while the processes are those of *Odontia*. It is not *Scopuloides* of Massee, as the processes are not merely clusters of cystidia. It may may stand as *Odontia pallida*, nom. nov.

290.—**Kneiffia discolor** B. & Br.

Berkeley and Broome described this in Fungi of Ceylon, No. 564, as "Tenuis, submembranacea, lobata, margine angustissimo, lactea, granulis rufis. Spread over the bark. The edge sometimes free."

This species is not uncommon at Peradeniya. It is resupinate, adnate, effused, with a byssoid margin at first. When old, the margin becomes solid and may recurve slightly in drying. When fresh, it is lilac, with a white margin, becoming white when old. It bears numerous clavate or conical processes, up to 50 μ diameter below, projecting about 60 μ above the surface. Between the processes the hymenium is smooth or minutely pruinose. The total thickness of the fructification varies from 0·1-0·2 mm., and it differs considerably in structure from point to point. In general, the lower part is yellow-brown, composed of agglutinated hyphae, more or less parallel to the substratum ,with a hyaline upper layer about 60 μ thick. The processes, which are composed of parallel hyphae and are red-brown or yellow-brown by transmitted light, arise from the yellow-brown stratum. Where the stroma is thicker, the yellow-brown stratum divides into two, one part overlying the substratum and the other lying below the upper hyaline layer, the intermediate tissue being hyaline ; and the processes then arise from the upper yellow-brown layer. The intermediate hyaline tissue may consist either of more or less parallel hyphae like the basal layer, or of loosely interwoven hyphae. Where the stroma is very thin, the yellow-

brown basal layer is almost lacking, and the processes appear to arise from the substratum. Developing processes, within the context, are covered by masses of calcium oxalate, and these remain round the bases of the fully-developed processes. The hymenium contains somewhat irregular tubes, which stain more deeply with iodine than the remainder of the hymenium and appear to be gloeocystidia. The basidia are those of *Heterochaete*, and the species must stand as *Heterochaete discolor* (B. & Br.). Its spores are hyaline, oval, inequilateral, 8-10×5-7 μ.

Heterochaete tenuicula (Lév.) differs in its definite stroma, separable from the substratum, and in colour when fresh.

291.—Kneiffia coriacea B. & Br.

Berkeley and Broome described this species as "Crassa, rigida, secernibilis, hymenio pallide umbrino granulis albis sparso, margine lato fusco. 4 inches across; margin barren."

The specimen in Herb. Peradeniya, Thwaites 991, is about 7 cm. broad, and evidently extended for at least double that length. It is livid grey, with small white spots, and a broad, glabrous, black, or here and there reddish-brown, margin. It is separable from the substratum, and apparently sometimes free towards the margin. The lower surface is black, strigose or tomentose with rufous-brown tomentum, united to the substratum at several points and often concentrically zoned round the points of attachment. The fructification is rigid, and up to 1 mm. thick, the surface cracking on drying (?). The section viewed macroscopically shows yellow-brown hyphae below, then a dense, black, horny basal layer, followed by a dark rufous-brown layer for about half the thickness of the stroma, and an upper, more purple-brown layer of about the same thickness, mottled with white.

By transmitted light, the sub-basal hyphae are yellow-brown, regular, thick-walled or solid, up to 5 μ diameter, and form a loose weft up to 0·1 mm. thick. The basal layer is red-brown, about 0·15 mm. thick. The tissue above this, for about 0·3 mm., is pale yellow-brown, and composed of fused hyphae, more or less parallel to the substratum as in the basal layer. This merges into an upper layer, about 0·4 mm. thick, yellow-brown below, becoming hyaline above, stratose, of vertically parallel, fused hyphae, etc. The specimen shows three successive hymenia. The whole section is sub-translucent. The hymenium contains numerous glococystidia with red-brown contents (in the dry specimen); these are very slender, 1-2 μ diameter, below, with long clavate tips, 4-5 μ diameter. Scattered through the old hymenia are masses of crystals of calcium oxalate; these give the mottled appearance when the fungus is cut. In the current hymenium, these masses occupy cavities,

up to 100 μ deep and 100 μ diameter, open above ; the masses may project 20 μ above the surface, and they form the white dots. These masses do not fall out, but are buried by the subsequent growth of another hymenium. The basidia are 6 μ diameter, clavate, somewhat attenuated above ; the spores are hyaline, oval, inequilateral, acute at the ends, 5 × 3μ.

This species is a *Stereum* (*Lloydella*), and will stand as *Stereum* (*Lloydella*) *coriaceum* (B. & Br.).

292.—**Kneiffia insularis** B. & Br.

Berkeley and Broome's description of this species is "Tenuis, sparsa, irregularis, immarginata, lobata ; hymenio centro subumbrino ; granulis minutis." They added, "There is also what we suppose to be a younger state, in which the plant is white, with a pinkish-grey tinge in the centre."

The specimen in Herb. Peradeniya is effused, in small, irregularly lobed patches, cream-coloured or pale ochraceous, pulverulent or byssoid, covered with minute processes. Sections show that the fungus is a mere film, sometimes up to 20 μ thick, sometimes barely covering the substratum. The processes are cylindric, up to 40 μ high, 20μ diameter, or irregularly globose, 50 μ diameter, or pulvinate masses partly embedded in the film. The context is composed of hyaline irregular hyphae, 1-2 μ diameter. The globose processes are superficial, and are masses of calcium oxalate bound together by a few hyphae ; on treatment with hydrochloric acid they disappear. The cylindrical processes, which are embedded in the film, are also composed largely of masses of calcium oxalate, but in some cases a loose column of hyphae is left after treatment with hydrochloric acid. The film contains ovoid basidia, 4 × 3 μ, in small clusters. The specimen is scarcely in a fit condition for determination, but it would appear to be a *Corticium*. The structure of the processes is not definite enough to decide its position.

The white species referred to by Berkeley and Broome is entirely different. It forms small, chalky-white, more or less circular patches, with scattered, minute, rounded elevations, about 0·1 mm. diameter. Where it is rubbed, it appears brown. It is about 0·2 mm. thick, with two well-defined layers, which readily separate from one another. The lower layer, about three-quarters of the thickness of the stroma, is composed of densely interwoven, yellow-brown hyphae, 2 μ diameter, not fused. The upper layer is hyaline, composed of irregularly flexuose hyphae, 2 μ diameter, bearing numerous branches which form, either short spines, or long slender hyphae 1 μ diameter, with minute, oval lateral conidia, 2·5 × 1·5 μ. It is not possible to decide what this is from this specimen, and it is doubtful whether it consists of one or of two fungi.

293.—Kneiffia chromoplumbea B. & Br.

This was described as "Luteo-fulva, margine tenui pulverulento byssoideo flavo ; hymenio granulato, setulis albis. Varying from chrome yellow to tawny. In one specimen, if really the same, the margin is white. It appears to turn brown when old."

From the specimen in Herb. Peradeniya (Thwaites 606), the fructification begins as an effused, bright chrome yellow patch, which acquires a thin, waxy or subgelatinous upper layer, and becomes rough with pulvinate tubercles, 0·2-1 mm. diameter, or irregular ridges ; some of these are due to irregularities in the substratum, but the majority are true variations in the thickness of the stroma. It appears to be densely covered, both on the flat and the elevated parts, with white cystidia, 0·1 mm. high, scattered or clustered, up to 40 μ diameter, usually clavate. These, however, are not true cystidia ; they consist of overlapping, more or less tabular masses of calcium oxalate, adherent to conical or cylindric processes, which are composed of parallel hyphae, compact, like the processes of a *Heterochaete*.

The fructification is up to 0·2 mm. thick in the flat parts, increasing to 0·5 mm. in the tubercles. In section the basal layer is red-brown, about 30 μ thick, and composed of agglutinated hyphae parallel to the substratum. The intermediate tissue is pale yellow, hyaline in thin sections, rather loose, and composed of slender interwoven hyphae. The hymenial layer is red-brown and somewhat horny in section, viewed as an opaque object, but translucent in thin sections. The upper part of the fructification contains numerous gloeocystidia with greenish-yellow contents ; these are narrow-oval, sometimes produced into a point above, 16-24 × 7-8 μ, with a slender stalk, 2 μ diameter ; they are situated at various depths and rarely reach the surface. The basidia are 6 μ diameter, four-spored.

Alcohol extracts a resinous or oily substance, which forms minute globules in water. On treatment with lactic acid, some parts of the pseudocystidia, and perhaps part of the contents of the gloeocystidia, dissolve, and the dissolved substance crystallises out again on the slide in radiating groups of long, greenish-yellow needles. These needle-shaped crystals do not dissolve in hydrochloric acid. Treatment with hydrochloric acid dissolves the tabular crystals on the pseudocystidia.

If a section is treated first with lactic acid and then with hydrochloric acid, the processes which form the foundation of the pseudocystidia are left free of any adhering substances, except some of the recently-formed needles. But if the section is treated first with hydrochloric acid, and the calcium oxalate masses dissolved, irregular masses of a greenish-yellow resinous substance remain adherent to the processes, and

subsequent treatment with lactic acid does not dissolve these or induce the formation of any needle-shaped crystals.

The combination of characters in this species makes its systematic position doubtful. For the present, I leave it under Berkeley and Broome's name, as it would appear to be equally out of place in any other established genus.

There is a single fragment of another species in Thwaites 606 in Herb. Peradeniya, apparently an immature *Asterostromella*. The Peradeniya specimen has not a white margin.

294.—Kneiffia isabellina B. & Br.

Berkeley and Broome's description of this species is "Tenuis, late effusa, margine tenuissimo pulverulento quandoque elevato ; hymenio isabellino, granulis minutissimis. Spreading far and wide ; surface continuous, of a delicate pinkish grey, covered with extremely minute granules."

Thwaites included under No. 655, a collection made in the Southern Province, July 1868, and another made in the Central Province, December 1868 ; and Berkeley and Broome cited both these as *Kneiffia isabellina*. In Thwaites 655 in Herb. Peradeniya, there are undoubtedly three collections, on different substrata.

The largest specimen, which is thin and widely effused, is pale brownish ochraceous, with a narrow, smooth, brown margin. The stroma is cracked near, and parallel to, the margin, which is not elevated in this specimen. The general surface is even, rough with minute, close-set granules arranged in irregular rows. The fructification is 0·3 mm. thick, internally pale-brown, mottled with white, when viewed as an opaque object. In sections by transmitted light, there is a very thin, yellow-brown, basal layer, scarcely differentiated from the remainder of the stroma. The context is pale yellow-brown or hyaline, somewhat in patches, and is composed of densely interwoven, agglutinated slender hyphae. It includes irregular, sub-cylindric masses of calcium oxalate, up to 0.2 mm. long and 50 μ diameter. These give the mottled appearance seen in section. Some of these masses are entirely immersed ; others reach the surface, and project up to 30 μ, forming the granules seen on the hymenium. Basidia have not been observed.

Another collection is represented by several small pieces. It was probably widely effused. The colour is slightly paler than that of the foregoing, and its surface is undulating. It has the same arrangement of granules. The margin differs, being narrow, of the same colour as the remainder of the fructification, tomentose, thick, and tending to separate from the substratum. The fructification is up to 1 mm. thick,

stratose, in two layers, the lower layer being about two-thirds the entire thickness. There is no marked basal layer. The context is the same as in the first collection, and it contains similar masses of calcium oxalate, up to 0·3 mm. long. The projecting ends of these masses are sometimes surrounded by a narrow up-growth of hyphae.

The third collection is effused, purple-grey, and has cracked into small areolae, exposing the inner tissue, which appears white in the cracks. It bears numerous projections, up to 75 μ high, either conical, up to 100 μ diameter at the base, or cylindric, up to 50 μ diameter. The fructification is 0.25 mm. thick, the internal tissue being yellow-brown to hyaline, rather compact, composed of slender irregular hyphae, sometimes agglutinated, sometimes loosely interwoven, without a differentiated basal layer, and containing large numbers of subglobose granules of calcium oxalate. The surface of the stroma, and the processes, are covered with similar granules, often resembling sphaerocrystals. After removal of the calcium oxalate with hydrochloric acid, the processes are found to consist of rather loose, more or less erect hyphae. Basidia have not been found.

The third specimen is perhaps an *Odontia*. The other two would appear to be identical with one another. Berkeley and Broome's description would fit the latter two together, but neither of them separately. But the only specimen which looks as if it could ever have been pinkish grey is the third. The first and second collection are probably a *Corticium*, but any change of name must be deferred until the type specimen in Herb. Kew has been examined.

295.—**Kneiffia Muelleri** Berk.

Grandinia papulosa B. & Br.

Kneiffia Muelleri was originally described by Berkeley from Australia in Jour. Linn. Soc., XIII, p. 167, as "Tota resupinata tenuis, junior farinulenta, senior continua hic illic rimosa granulis perithecii-formibus apice niveis. When the granules have fallen off, it looks like a *Porothelium*." It was recorded for Ceylon by Berkeley and Broome, with the note, "This very curious species is at once distinguished by the granules falling out and leaving little holes. The Ceylon specimens seem the same with those from Australia, but are of a purer white."

The specimen (660) which Thwaites retained in Herb. Peradeniya is pale yellow, effused, thin, even, 50-100 μ, thick, closely studded with circular holes, 0·1-0·3 mm. diameter, sometimes confluent in short branching lines, which appear to expose the substratum. In some of these holes there is a minute white mass in the centre, united to the sides by fine, radial strands. At one side of the specimen the margin is chiefly

white and byssoid. At the other side there are waxy, pale ochraceous patches, which bear minute, paler, circular areas ; and on examination under a low magnification it is seen that on these pale spots the surface layer is raised and cracked, and finally recurves, forming a crater-like cavity. These are the first stages of formation of the holes in the stroma. When fully formed, the margins of the holes are smooth and do not indicate the mode of origin.

The context is composed of loosely interwoven, hyaline hyphae, enclosing large numbers of granules of calcium oxalate, and has a thin, pale yellow, surface layer about 12 μ thick. It contains numerous cavities, which extend almost from the base to the upper layer of the fructification, and are filled with granules of calcium oxalate. The upper layer overlying a cavity breaks up and disappears ; and the granules fall out, leaving a hole which descends almost to the base of the stroma. In some cases, a small mass of granules, bound together by hyphae, persists in the centre of the cavity. Basidia have not been observed in this specimen.

In Fungi of Ceylon, No. 559, Berkeley and Broome described *Grandinia papulosa* B. & Br., as " Effusa, ochroleuca, margine angustissimo vel obsoleto ; hymenio glabro papulis obtusis depressis, interstitiis laevibus. Spreading for some inches. Hymenium sprinkled with scattered depressed granules."

There are three pieces of this in Thwaites 995 in Herb. Peradeniya, bearing examples of the fungus which differ in thickness. The smallest and youngest patch, only about 2 cms. long, is exactly the same as the Peradeniya specimen of *Kneiffia Muelleri*. Another thicker piece, up to 0·15 mm. thick, is covered with scattered minute elevations and small white masses ; this again has the same structure as the specimen of *Kneiffia Muelleri*, the white masses of granules descending almost to the base, and the minute elevations being points where the upper layer has not broken away. The third and largest piece evidently extended for several inches ; it is cream-coloured (?) without a differentiated margin, or with a narrow, brown, glabrous margin, and covered with flattened-pulvinate, white masses, up to 0·4 mm. diameter ; it is up to 0·5 mm. thick, stratose, the old hymenia appearing as pale yellow and translucent zones in thick sections ; the structure is that of " *Kneiffia Muelleri*," the masses of granules descending almost to the base of the stroma. In the thicker stromata, the granules have not fallen out.

Berkeley and Broome stated that the granules were depressed. The masses are more or less flat-topped, and tend to spread out in lobes over the surrounding hymenium. In some instances, the part of the superficial layer which originally covered one persists as a minute brown cap.

The thicker fructifications have minute, hyaline, rough cystidia, obtuse, cylindrical above, suddenly attenuated below, 12-14 μ long, 5-6 μ diameter, projecting 8-20 μ, and only slightly embedded. The basidia are clavate, 4 μ diameter, with slender sterigmata 2 μ long. Cystidia have not been found in the young, thin examples.

The masses of granules which appear as white spots on the hymenium are similar to those of *Kneiffia coriacea*. They would not appear to constitute a generic character. *Grandinia papulosa* is identical with the Ceylon specimen of *Kneiffia Muelleri*, and is a *Peniophora*. The Australian type specimen of *Kneiffia Muelleri* has not been examined, and hence it is not yet possible to make any statement regarding it, or to settle the name of the Ceylon species. From Berkeley's description the Australian fungus would appear to be different.

296.—Kneiffia setigera Fr.

Berkeley and Broome recorded this species for Ceylon from Thwaites 654. There are two different species in Thwaites 654 in Herb. Peradeniya, but neither bears *Peniophora* setae, and consequently neither is *Peniophora setigera* (Fr.) Bres.

297.—Grandinia granulosa Fr. var. candida

Berkeley and Broome recorded this in Fungi of Ceylon, No. 560, from Thwaites 327, without description. Thwaites, in Herb. Peradeniya, placed his 326 and 327 on the same sheet. Berkeley and Broome apparently did not describe Thwaites 326. The mixture contains three species, two of which might be styled candida, while the third is subtranslucent. The first two have *Peniophora* setae ; the third has long, slender, hyaline setae, united laterally into compact columns, up to 120 μ high and 30 μ diameter. None of these is *Grandinia granulosa* Fr.

298.—Grandinia lateritia B. & Br.

This was described in Fungi of Ceylon, No. 561, as " Effusa, lateritia, farinacea, granulis distinctis ; margine, si adsit, pallidiore tomentoso. Very much the colour of *Kneiffia fulva* B. & C., a Cuban species ; but the hymenium is very different."

The specimen, Thwaites 334, in Herb. Peradeniya, is effused, red-brown, pruinose, covered with minute more or less conical projections, soft, and with a byssoid margin. It is up to 0·3 mm. thick, loose and spongy internally, very loose at the base, hyaline below, becoming red-brown above. The hyphae are pale red-brown in mass, almost hyaline individually ; at the base of the fructification they are 2-3 μ

diameter, regular ; in the upper part they are more slender, down to 1 μ diameter. All the hyphae are more or less encrusted with minute globose masses of calcium oxalate. The conical projections are up to 150 μ high, and 200 μ diameter at the base ; they are composed of rather loosely interwoven hyphae, and are covered by the hymenium except at the apex. A narrow column, denser than the intervening part of the fructification, traverses it, vertically, beneath each projection, but is not composed of vertical parallel hyphae. The basidia are clavate, 12 μ high, 6 μ diameter, with short sterigmata. The spores are pale yellow-brown, spinulose, globose, 4-5 μ diameter, or oval, up to 8×6 μ.

This species is a *Tomentella*. As it has projections on the hymenium it might be placed in *Caldesiella*, but the projections are scarcely sufficiently marked for that genus. *Tomentella lateritia* being already occupied, it may be known as *Tomentella rufobrunnea* nom. nov.

299.—Merulius versiformis B. & Br.

Berkeley and Broome described this species from Thwaites 660 as " Tenuis, primum pulverulentus graniferus ex ochraceo rufus, demum gelatinosus ; hymenio vix poriforme. At first forming a thin ochraceous pulverulent stratum, which is scattered with granules after the fashion of a *Grandinia* ; but the hymenium gradually changes colour, and becomes of a gelatinous texture, with raised irregular processes, which hardly form pores."

In Thwaites 660 in Herb. Peradeniya, there are three species, one on bark of a dicotyledon, a second on *Oncosperma* (?), and the third chiefly on fragments of wood. I have not examined the type in Herb. Kew, but it would seem probable that a similar mixture occurs in it, as Berkeley and Broome's description appears to refer to at least two of the three species.

The specimens on fragments of wood are ultimately gelatinous and furnished with distinct processes ; consequently these may be taken as *Merulius versiformis*. The fungus begins as a thin byssoid layer, on which minute, red-brown, translucent, slightly pulvinate masses develop Ultimately a continuous, red-brown, thin, gelatinous layer is formed, from which arise minute scattered processes. The gelatinous layer is up to 60 μ thick, translucent, and composed of fused hyphae more or less parallel to the substratum. The processes are similarly translucent, conical or subcylindric, projecting about 50 μ ; they arise from the base of the stroma and are composed of parallel hyphae. No basidia have been observed. The specimen is immature, and might be a *Heterochaete* or an *Odontia*. It is surely not a *Merulius*, and Berkeley and Broome's name should be discarded. The descriptions of the other

two species in Thwaites 660 are as follows, the colours being those of the herbarium specimens.

Peniophora (*Scopuloides*) *ceracea* Petch, n. sp. Effused, dull orange red in the centre, passing into ochraceous, then yellow, outwards, with a narrow, byssoid or pulverulent, white margin, waxy, slightly pruinose ; up to 0·1 mm. thick, the lower half composed of loosely interwoven, irregular hyphae, enclosing numerous masses of calcium oxalate, the upper half yellow, compact, subtranslucent ; cystidia hyaline, cylindric, obtuse, encrusted, 36-50 μ high (probably longer), 8-10 μ diameter, projecting up to 30 μ, fasciculate in groups up to 60 μ diameter ; basidia cylindric, 12 μ long, 3 μ diameter ; spores oval, spinulose, 4 × 3 μ. On bark, Central Province, Ceylon ; Thwaites 660 in part.

Peniophora fracta Petch, n. sp. Effused, ochraceous (?), uneven, cracking into small areolae when dry, pruinose ; up to 0·2 mm. thick, internally stratose, yellow-brown with red-brown zones below, pale yellow above; tissue loose, of stout irregular hyphae and irregular yellow-brown translucent masses of fused hyphae and cystidia ; basal layer of yellow-brown hyphae parallel to the substratum ; cystidia hyaline, encrusted, cylindric, obtuse, up to 80 μ high, 8 μ diameter, projecting 25 to 45 μ, scattered on the surface, but crowded in the buried zones. On *Oncosperma* (?), Central Province, Ceylon ; Thwaites 660 in part.

300.—**Clavaria chlorina** B. & Br.

This was described in Fungi of Ceylon, No. 680, as " Simplex vel subramosa rugosa viridis, stipite tenui (No. 200). On the ground amongst leaves, Nov. 1867. Sometimes forked or proliferous. Spores ·00015 long, setulose. "

The specimens are up to 5 cm. high, simple, or with a short lateral branch near the base, 1 mm. diameter below, elongated fusiform or clavate, expanding to 2 mm. diameter above, laterally compressed (? only in drying), pruinose below, waxy above, apex obtuse. In section, the clava shows a central, horny and subtranslucent core, surrounded by a loose plectenchymatous tissue, 30-60 μ broad. The hyphae are chiefly thin-walled, but both in the central core and the looser peripheral layer, there are scattered, solid hyphae, 4 μ diameter, which stain deep yellow-brown with iodine. At the exterior, the plectenchymatous tissue forms a continous layer of cells about 4 μ diameter and 6 μ deep, and from each of these there arises a cluster of elongated flask-shaped phialides, about 15 μ long, 2 μ diameter below, tapering to the apex. The phialides form a yellow palisade layer, which contrasts strongly with the hyaline looser tissue below it. The clava bears a dense layer of spores, which are pale

yellow, faintly warted, oval, 2-3 × 1·5-2 μ. Berkeley and Broome's "setulose" was probably a misprint for spinulose.

This fungus is evidently not a *Clavaria*. It is a conidial species, but not the conidial stage of a *Penicillopsis*. Its true position is doubtful.

301.—Lycoperdon fucatum Lév.

The list of Ceylon fungi sent by Gardner (Decades of Fungi, XV-XIX, Hooker's Lond. Jour. Bot., VI, pp. 479-514), Berkeley recorded *Lycoperdon fucatum* Lév., Gardner No. 16.

In the cover of *Lycoperdon fucatum* in Herb. Kew, there are two Ceylon gatherings. One marked "Ceylon, Gardner" consists of four parts of specimens; it is immature, but appears to be *Sarcoxylon aurantiacum*. The other contains one specimen, marked "16, on old trees, Hantane, June 44" by Gardner, and "*Lycop. fucatum* Lév." by Berkeley. This latter specimen is *Lasiosphaera Fenzlii* Reichardt. The statement that it grew on trees is probably an error, as all specimens recently collected have grown on the ground. Massee, Mon. Genus Lycoperdon, (Jour. Roy. Microscopical Soc., 1887, pp. 701-727) recorded *Lycoperdon fucatum* for Ceylon, and stated that it grew "on the ground and on old trees," the latter habitat probably having been taken from the herbarium sheet of the Ceylon specimen.

302.—Lycoperdon rugosum B. & C.

This species was recorded for Ceylon in Berkeley and Curtis, Cuban Fungi. No. 504, and the record was repeated by Massee in Mon. Genus Lycoperdon (*loc. cit.*). There is no Ceylon specimen of *Lycoperdon rugosum* in the cover in Herb. Kew.

303.—Sclerotium (Mylitta) ligulatum Ces.

Cesati, in his account of the fungi collected in Ceylon and Borneo by Beccari, described *Sclerotium ligulatum*, which was found on Pedrotalagalla, Ceylon. It was "Olivaceum, difforme, cylindraceum v. compressiusculum, pistillare vel turbinatum, passim bifidum, carnosum, intus album, contextu e vesiculoso granulari". What is believed to be the same species was collected in a cave on Pedrotalagalla in 1904. and has been found common in certain fields on an up-country tea estate,

The sclerotia are irregularly ovoid or subglobose, usually with a more or less undulating surface, and of the same variability in size and shape as a potato. The largest specimen seen measures 6×4·5 × 4 cm. The colour is brown, or blackish-brown, externally, and the surface is rough and divided into more or less polygonal areolae, separated by shallow

furrows. Internally the sclerotium is very hard, and consists of translucent masses separated by white veins. It is evidently a *Mylitta*.

Berkeley, Currey, and Hanbury in Trans, Linn. Soc., XXIII (1860), pp. 91-96, described a similar sclerotium from India. Berkeley stated that its structure was very like that of *Mylitta australis*, and, though there was a slight difference in the outer coat, it was probably the same as the *Mylitta* of China, *Mylitta lapidescens* Horaninow. Currey and Hanbury agreed that the Chinese and Indian species were the same. Butler (Fungi and Disease in Plants, p. 13) states that *Mylitta lapidescens* occurs in the Nilgiris, where it is known as " Little man's bread. "

It is most probable that the *Mylitta* from South India is identical with that of Ceylon, though, of course, it is impossible to make any correct statement until the fructification has been found in each case. In Ceylon, the only basidiomycetous fungus known to grow from a true sclerotium is *Fomes rhinocerotis* Cooke, but that has been found only in the low-country, while *Sclerotium ligulatum* is known only from above 3000 feet. Pedrotalagalla being the highest point in the Island. But, in the absence of fructifications, the name *Mylitta ligulata* should be employed for the Ceylon species, rather than *Mylitta lapidescens*, as the type locality of the latter is China, not India, and consequently it is most probable that the two sclerotia belong to different species of fungi.

One correspondent informed me several years ago that in the Nuwara Eliya district (Pedrotalagalla) these sclerotia are cooked and eaten, but I have not been able to obtain confirmation of that. They are known by the Sinhalese name, Sita aggala, and by the Tamil name, Ravanon kolai koddai, from which it would appear that they are more widely distributed than our records show. Both these names have reference to the following well-known incident in the legendary history of Ceylon.

Sita, the wife of Rama, King of India, was abducted by Ravana and carried off to the jungles of Ceylon. There she fasted forty days, and during that period, being desirous of making certain offerings, asked for fruits, etc., to be supplied. Ravana, however, sent her cooked rice, whereupon, she, considering that an attempt to induce her to break her fast, made the rice into balls and threw it away, at the same time invoking curses on Ravana and all his family. Sita aggala means Sita's cakes, while Ravanon kolai koddai may be translated as the fatal gift of Ravana.

304.—**Nectria stenospora** B. & Br.

This species was discussed in Hypocreaceae Zeylanicae (Ann. Perad., VII, p. 104). It was described by Berkeley and Broome in Fungi of Ceylon, No. 1011, as " Caespitosa e matrice alba oriunda ; peritheciis minutis pellucido-coccineis collapsis ; sporis angustis uniseptatis. On

soft decaying stems. South of the Island, July 1868. Sporidia 10-12·5 μ long, 2·5-3·75 μ wide."

The specimen was part of Thwaites 647, a number which provided *Nectria stenospora*, *Nectria trichospora*, *Nectria sanguinea*, *Nectria bicolor*, *Nectria Bambusae*, and *Nectria pityrodes* var. *saccharina*.

The supposed type specimen in Herb. Kew has been examined by von Höhnel, who found that it contained five species, *viz. Nectria stenospora*, *Nectria bicolor*, *Nectria luteococcinea* (=*N. haematococca* B. & Br.) *Calonectria sulcata* (=*Calonectria rigidiuscula* B. & Br.), and *Nectria flocculenta* (=*Nectria flavolanata* B. & Br.). von Höhnel stated that *Nectria stenospora* occurred sparingly on the type specimen ; it was apparently so scanty that there are now no specimens left. von Höhnel indicated on the herbarium sheet the position of the last four species, but he did not mark *Nectria stenospora*.

The species which von Höhnel took as *Nectria stenospora*, according to his description (Mitt. XIV, p. 31) has perithecia situated in small groups on a feebly developed, erumpent stroma ; they are cinnabar-red, globose, not collapsing, smooth, 250-280 μ diameter, with a small, flat, ostiolar papilla. The asci are clavate, with biseriate spores, 50-60 ×9-10 μ. The spores are straight, elongated-elliptic, with obtuse ends, not constricted at the septum, hyaline, with four or five longitudinal striae, 10-14 × 4-5 μ.

As previously pointed out (*loc. cit.*) von Höhnel's description differs from Berkeley and Broome's in several details. The latter state that perithecia arise from a white stroma, are pellucid red, and collapse ; von Höhnel does not refer to a white stroma, does not describe the perithecia as translucent, and states that they do not collapse. Because of these discrepancies, it was suggested, in dealing with this species in Hypocreaceae Zeylanicae, that the name should be applied, not to von Höhnel's species, but to another which formed part of Thwaites 647 and is otherwise unrecorded.

However, on consulting the Herbarium of the British Museum (Natural History), it was found that that Herbarium possessed an ample specimen of *Nectria stenospora*, *ex* Herb. Broome, which answers completely to the macroscopic characters of the original description. Under this name in Herb. B. M. are two sheets *ex* Herb. Broome. One of them is Ceylon 647 ; the fungus is on dead herbaceous stems, and it appears to be all the same species ; it is accompanied by a drawing, and a spore measurement "0. 0004-0·0005 l., 0·0001—0·00021 w." This is undoubtedly *Nectria stenospora* B. & Br. The other specimen is marked 647 bis ; it is a mixture, and contains the species which I suggested in Ann. Perad., VII, p. 106 was *Nectria stenospora*.

In Thwaites 647, *Nectria stenospora*, in Herb. B. M., the perithecia are in small groups, either without a visible stroma, or situated round a yellowish white tuft of hyphae. The perithecia collapse centrally; they are either pale ochraceous and almost opaque, or dark brownish red and subtranslucent, both colours occurring in the same group The perithecia are globose, with a minute, conical ostiolum, 0·2-0·25 mm. diameter, at first pruinose, becoming almost glabrous, rugose; when mounted, the perithecial wall is pale yellow. The asci are clavate, eight-spored, with spores biseriate above and uniseriate below, 50 × 8 μ. The spores are narrow-oval, ends obtuse, not, or slightly, constricted, one-septate, hyaline, minutely verrucose, 10-14 × 4-5 μ.

There is not much doubt that this is the real *Nectria stenospora* of Berkeley and Broome. But it is also quite evidently *Nectria bicolor* B. & Br. von Höhnel did not describe *Nectria bicolor*, but stated that it was scarcely different from *Nectria ochroleuca*. Berkeley and Broome's description of *Nectria bicolor* does not differ much from that of *Nectria stenospora*, and it would appear that they gave the former name to specimens which lacked the white matrix. The spores of *Nectria bicolor* were given as 8·75 μ long and 2·5 μ broad.

Nectria bicolor B. & Br. is consequently a synonym of *Nectria stenospora* B. & Br.

In one recent gathering of *Nectria stenospora*, the ascospores are 8-10 × 3 μ, rarely 4 μ broad. The conidial stromata are pulvinate, rather loosely-built, pink, sometimes with a white byssoid margin; the conidiophores are short and branched, and the conidia are narrow oval, 4-11 × 1·5-3 μ.

The remaining *Nectria* of Thwaites 647, which occurs in Herb. Kew in the cover of *Nectria bicolor* and in the cover of *Nectria sanguinea*, is apparently undescribed. It may be known as *Nectria flavistroma*.

Nectria flavistroma n. sp. Perithecia densely crowded on an erumpent stroma in pulvinate masses up to 5 mm. diameter. Stroma parenchymatous, composed of small thick-walled cells, or somewhat sclerotioid, orange-red above, yellow internally, paler towards the base. Perithecia bright red, becoming dark red, subtranslucent, glabrous, ovoid or suburceolate, 0·15-0·25 mm. diameter; ostiolum broadly conical, darker than the perithecial wall, ochraceous at the apex; perithecial wall, in section, yellow internally, red towards the exterior, composed of thick-walled cells 8 μ diameter, the outer layer somewhat amorphous. Asci sessile, narrow-clavate, 50-65 × 6-9 μ, eight-spored, spores obliquely uniseriate. Paraphyses linear. Spores hyaline, oval, obtuse, not constricted, one-septate, 10-13 × 4-7 μ.

Parasitic on Sphaeriaceae, Ceylon: Thwaites 647 in part.

305.—**Nectria villigera** B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 1012 (Jour. Linn. Soc., XIV, p. 115) as " Conglomerata : peritheciis ovatis rugosis pallidis : floccis conidiiferis conidiis longiseptatis magnis ellipticis vel obovatis (No. 156). Apparently on some decaying fungus. Nov. 1867. Surface of perithecia rough. "

I was unable to find the type specimen of *Nectria villigera* in Herb. Kew, or Herb. British Museum in 1915, and consequently this species could not be redescribed in " Hypocreaceae Zeylanicae ", Ann. Perad., VII, pp. 85-138. In 1926, during an examination of the Kew specimens of *Nectria* for scale insect parasites, the type of *Nectria villigera* was discovered.

The specimen answers to Berkeley and Broome's description. It consists of subglobose or ellipsoid bodies, heaped together in loosely caespitose masses. The individual " perithecia " are rough, subtranslucent or opaque, pale yellow, dark amber, dark orange, or dark red brown, 0·2-0·25 mm. diameter. They are bound together by scanty hyaline mycelium, and sometimes bear scattered, erect, hyaline hyphae.

Examination shows that these are masses of insect frass, bound together by mycelium. The mycelium is probably that of a *Fusarium*. I was able to obtain only small, non-septate, hyaline conidia.

The name *Nectria villigera* is consequently to be discarded.

306.—**Sphaerostilbe lateritia** B. & C.

This species was recorded for Ceylon by Berkeley, in Fungi Cubenses, Jour. Linn. Soc , X (1869), p. 377. There is no Ceylon specimen in the herbaria of the British Museum and Kew, but in the latter there is a specimen collected by Gardner in Brazil in 1841, which may be the one Berkeley had in mind, as Gardner subsequently came to Ceylon and the name of the locality on the specimen, Maranham, resembles a Ceylon name.

307.—**Hypocrea multiformis** B. & Br.

For this species, Berkeley and Broome cited the Thwaites' numbers, 1094, 1095, 1096, 33 in part, in Fungi of Ceylon, No. 995. 1096 is 33 in part, while 1094 and 1095 are parts of Thwaites 5. This species was discussed in Ann. Perad., VII, p. 96, where it was pointed out Berkeley and Broome cited 5 in part, 1094, for *Hypocrea citrina* var., and 5 in part for *Hypocrea albofulva* B. & Br., *Hypocrea discella* B. & Br., and *Hypocrea catoptron* B. & Br., and that the herbarium specimens were mixtures. In conclusion, it was stated " It may be that there is another

species in Tawaites 1094 in Herb. Kew or Herb. British Museum, to which the name *Hypocrea multiformis* might be applied, but in view of the mixture cited by Berkeley and Broome it would seem preferable to discard the name."

Since then the specimens in Herb. Kew and Herb. British Museum have been re-examined. Confining attention to Thwaites 1094, it has been found that in both herbaria there are two sets of specimens under that number. In Herb. Kew, each set of specimens contains two species, part being marked *Hypocrea multiformis* and part *Hypocrea citrina* var. In Herb. British Museum, there is apparently only one species in the two specimens marked *Hypocrea multiformis*. The *Hypocrea multiformis* of these specimens proves to be distinct from those previously examined, and if the name be restricted to Thwaites 1094 in Herb. B. M., and the part of 1094 so labelled in Herb. Kew, it will stand as a valid species. It is near *Hypocrea citrina* var. (=*Hypocrea straminea*) in some respects, but apparently sufficiently distinct. It has not been matched by any recent gathering.

Berkeley and Broome's description probably refers to more than one species. The specimens are not "umbrinella," and the perithecia are not prominent.

The stromata are discoid, up to 1·5 mm. diameter and 0·6 mm. thick, with a rounded margin, attached over a central area the diameter of which is about one third that of the base, but not contracted below. The surface is slightly irregularly wrinkled and tuberculate, and the margin incised. The stromata are ochraceous, with dark brown ostiola, which are punctiform and almost black when the perithecia are immature; they appear opaque, but the internal tissue is subtranslucent in section. The perithecia are crowded in a single peripheral layer, the tissue between the bases of the perithecia being yellow; they are globose, 0·15-0·2 mm. diameter, or laterally oval, 0·25 × 0·15 mm., with a yellow wall. The asci are about 60 μ long and 3 μ diameter. The part-spores are not quite mature; they are greenish hyaline, almost smooth, globose, 3 μ diameter, or cuboid, 4 × 3 μ.

308.—Botryosphaeria catervaria (B. & C.) Sacc.

In Saccardo, Sylloge, I, p. 462, there is listed "*Botryosphaeria catervaria* (B. & C.) Sacc., *Diatrype catervaria* B. & C. in N. Pac. expl., p. 128, n. 156.—Stromatibus parvis in maculis aggregatis, papilla centrali notatis, quandoque confluentibus; ascis brevibus; sporidiis globosis. Hab. in foliis *Fici*, Hongkong, Ceylon."

In Annales Mycologici, XIV, p. 329, Theissen remarked that "Stromata die mit einer gemeinsam Zentralpapille versehen sind, konnen

nicht einer *Botryosphaeria* angehoren ; auch kugelige Sporen sind der Gattung fremd. "

Diatrype catervaria was not included by Berkeley and Broome in the Fungi of Ceylon. As far as the Ceylon reference is concerned, this is probably the specimen on *Ficus oppositifolia* (*Ficus hispida* L. f.), collected by Thwaites, Oct. 12, 1850, and recorded by Berkeley in Hooker's Journal of Botany, 1854, p. 231, as *Dothidea repens* (Corda) var. *catervaria*. It now stands as *Phyllachora catervaria* (Berk.) Sacc.

309.—**Botryosphaeria inflata** Cke. & Massee.

This species was re-described in Ann. Perad., VII, p. 26. Cooke and Massee found, on the type specimen, *Nectriella gigaspora* Cke. & Mass. The latter was re-described in Ann. Perad., VII, p. 122, as *Pseudonectria gigaspora*. von Höhnel, in discussing *Botryosphaeria xanthocephala* (Syd. & Butl.) Theiss., which has a black stroma with yellow beaks, suggested that *Botryosphaeria inflata* is identical with the latter, Cooke and Massee having mistaken the yellow beaks for *Nectriella* perithecia (Fragmente zur Mykologie, XXIV, p. 7). *Botryosphaeria inflata*, however, does not possess yellow beaks, and *Nectriella gigaspora* is a distinct species, which is parasitic on Sphaeriaceae, etc.

310.—**Micropeltella Thwaitesii** Petch.

In Annals Peradeniya, VII, page 34, it was shown that the specimen from Ceylon, listed by Berkeley and Broome as *Micropeltis applanata* Mont., was not that species. It had two-septate spores, and had no paraphyses. The name *Micropeltella Thwaitesii* was adopted for it, with the suggestion that Sydow's genus *Micropeltella*, as limited by Theissen, should be enlarged to include species with spores two-septate.

Specimens of this fungus have recently been collected on *Aporosa lanceolata* Thw., and with the help of these the former description can be extended. The perithecia occur on the upper side of the leaf ; they are scattered, black, scutate, circular, slightly radially rugose, about 0·5 mm. diameter, with the centre elevated and somewhat columnar. The cover is netted, not radial, opaque in the centre, becoming hyaline at the margin ; in Berkeley and Broome's specimens there is a distinct blue-green tinge at the edge of the cover, but this is not evident in the more mature recent examples. There is no trace in the latter of the layer of crystals noted in the former. The asci are clavate, sessile, eight-spored, 55 × 12 μ. The spores are greenish hyaline, fusoid, straight or curved, five-septate, constricted at the septa, ends rounded, the upper cell usually the larger, 20-25 × 6 μ. On re-examination, similar spores have been found in Berkeley and Broome's specimen.

There is consequently no need to extend the genus *Micropeltella* in order to include this species.

311.—Phoma pelliculosum B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 801, as "Griseum, e matrice secernibile ; peritheciis minutissimis epidermidem elevantibus ostiolo amplo ; sporis angustis, quam sporophoribus triplo brevioribus (No. 438). On bamboo. Peradeniya, December 1867. Peeling off in little ragged shreds : spores ·0001 long."

The bamboo bears a very thin, grey or greenish film, in which the pycnidia are embedded. The latter are scattered, black, up to 0·15 mm. diameter, flattened-convex, ostiolate, at first covered by the film, and ultimately breaking through it. The base of the pycnidium is flat and hyaline, and rests on the bamboo. The upper wall is black, opaque, fragile, with a fimbriate lower edge which shows a radial hyphal structure at the extreme margin : it forms a shield-like cover to the pycnidium. The ostiolum becomes widely open, the cover breaking away so that only a ring remains. A few fuscous hyphae, 2-4 μ diameter, run over or in the film.

The grey film can be peeled off the substratum, and it brings away with it the whole of the pycnidia, no evident trace of them being left on the bamboo. In the type specimen, the broken pycnidia then appear as rings up to 50 μ broad, with a hyaline inner ring of spores and basidia, surrounding a central hole.

The spores are minute, hyaline, oblong-oval, 3-5 × 1-1·5 μ, with many globose, 1 μ diameter. The basidia are short and simple, about 6 μ long, with a few long paraphyses, up to 50 μ long.

In Kew Bulletin, 1921, p. 150, Grove transferred this species to *Eriothyrium* Speg., at the same time amending the generic description of the latter. *Eriothyrium*, as amended by Grove, includes species which have scutato-dimidiate pycnidia, which are adnate, ostiolate, surrounded by an effused, very thin, smoky or fuscous-pallid subiculum, and have hyaline, continous spores.

Grove's description states that the pycnidia are black, 50-100 μ diameter, crowded, round, shield-shaped, dimidiate, applanato-convex, pierced by a wide, central, round or irregularly impressed pore ; texture of dark-brown cells, about 2-3 μ diameter, distinctly radiating especially at the margin ; spores narrow-oblong, straight or curvulous, about 3 × 1 μ ; sporophores rod-shaped, up to three times as long, springing from the underside of the shield.

Grove describes the fungus as occurring under the cuticle of bamboo stems. "The mycelium appears to arise in the epidermal cells, which

it ultimately destroys, leaving a layer of hyphae lying on the sclerenchymatous zone which underlies the epidermis and separating easily therefrom." "The pycnidia are immersed in, and at first covered by, a thin membranous subiculum, which appears to be composed of densely interwoven, pallid hyphae, adherent to the cuticle ; at length the vertex of each shield emerges from the weft, splitting the cuticle and opening by a pore which gradually grows wider ; ultimately the shield falls away entirely, leaving a little pit. The cells of the subiculum are thin-walled, very indistinct and tightly packed, forming a pseudoparenchyma, but occasionally the course of the separate radiating hyphae can be discerned."

In the specimens in Herb. Peradeniya, no radial structure is evident in the shield except at the margin. Otherwise Grove's re-description agrees with Ceylon observations, with the following exception. The film in which the pycnidia are embedded is quite superficial. It is composed of irregular hyphae, 1-2 μ diameter, thick-walled or almost solid, with a narrow interrupted lumen. These hyphae form a network in the thinner parts, but become more interwoven and denser in the older parts, and are intermingled with alga cells. When fresh the film is green at first, becoming greyish green later. It is particularly conspicuous on the stems of the yellow bamboo, the natural surface of which is glabrous.

There does not appear to be any doubt that the superficial film is a lichen thallus, and that the fungus is parasitic on the lichen, not on the bamboo. As the film is not the mycelium of the fungus, the latter cannot be assigned to *Eriothyrium*. It would appear to be *Actinothecium*, and may stand as *Actinothecium pelliculosum*.

312.—Phoma coryphae Cooke & Massee.

The description of this species was published in Grevillea, XIX, p. 75, in an unsigned article entitled "Omitted Diagnoses", which professed to contain descriptions which had been omitted from Saccardo's Sylloge. Some of these descriptions, however, including the one under notice, had never been previously published, and consequently no blame could attach to Saccardo for the alleged omission.

Phoma coryphae was described as "Peritheciis laxe gregariis erumpentibus, conicis, basi insculptis, atris, papillatis (0·5-0·3 mm). Sporulis arcte ellipticis, utrinque rotundatis, hyalinis, 12 × 3 μ. On palm petioles. Ceylon, 649."

The type specimen in Herb. Kew bears a label with the inscription by Thwaites "No. 649, S. of the Island, July 1868." Thwaites 649 was *Sphaeria agnocystis*, and the type of the latter bears another Thwaites's label with the same inscription, and in addition the words "compare

with 268." There is also, under *Sphaeria agnocystis*, another piece labelled "Ceylon, 649," *ex* Herb. Currey (?), which is the same as *Phoma coryphae*.

Cooke and Massee wrote the specific name without a capital. It is doubtful, therefore, whether they believed the host plant to be *Corypha*. If they did, it is not clear whence they derived that information. The host is a bamboo.

The surface of the host plant is covered by a thin greenish-grey layer with a black margin running transversely across the stem. This is a lichen. Over the surface of the lichen run widely-separated, dark-brown hyphae, 2-4 μ diameter. The pycnidia are seated on the exterior of the bamboo, and break through the lichen covering. They are up to 0·3 mm. diameter, and 0·3 mm. high, black, conical, with an even or papillate ostiolum. The wall is brittle, carbonaceous and opaque except at the extreme margin. The base is flat, black, except in the centre, where there is a subtranslucent circular area about 12 μ diameter. On peeling off the lichen, the pycnidia are detached with it, except for a narrow, irregular, interrupted ring derived from the margin of the pycnidium. This ring consists of irregularly fused, more or less radial, dark brown hyphae, 2-3 μ diameter. The base of the pycnidium is not immersed in the tissues of the bamboo

The spores are hyaline, cylindric or oblong oval, 3-5 × 1·5-2 μ. They are borne on short, simple basidia, up to 8 μ long, with which are intermingled a few long hyaline paraphyses, up to 50 μ long, 1 μ diameter. The pycnidium contains quantities of calcium oxalate in large irregular masses, up to 32 × 20 μ.

This species is similar in structure to *Phoma pelliculosum*. Like the latter, it is parasitic on a lichen, and it has exactly the same spores and paraphyses. It differs from *Phoma pelliculosum* in its larger pycnidia, and in leaving a ring, the margin of the pycnidium, attached to the host plant when the lichen film is peeled off. The latter may be a consequence of the greater development of the pycnidia. The differences do not appear to warrant the separation of *Phoma coryphae* from *Phoma pelliculosum*.

313.— **Phoma Lobeliae** B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 802, as "Pustulis epidermide alba tectis, demum emersis; sporis ellipticis (No. 301). On *Lobelia nicotianaefolia*, Nuwara Eliya. Spores ·00015 long."

No fungus answering to this description could be found in the co-type in Herb. Peradeniya, and consequently in a previous communication it was suggested that the species was a *Phomopsis* which occurs

on the same host at Nuwara Eliya. An examination of the type in Herb. Kew has, however, shown that that is incorrect.

Lobelia nicotianaefolia has flowering stems up to about four feet in height and an inch and a half in diameter. These are a prominent feature in the landscape at Nuwara Eliya, both during and after flowering. The stems are woody, and they take several months to decay. Consequently the erect dead stems persist for a long time. The type specimen of *Phoma Lobeliae* is on a piece of a decaying stem ; it consists of part of the woody cylinder, covered chiefly by the persistent membranous epidermis. Berkeley and Broome's " epidermide alba " refers to the spots where nothing but the bleached epidermis overlies the wood.

The pycnidia are superficial on the wood, either scattered or in small groups, with the ostiola just penetrating the epidermis. When the dead epidermis is removed, the pycnidia can be lifted off the wood with a needle. They are about 0·3 mm. diameter, globose or flattened globose, with a small conical ostiolum, black, not carbonaceous. When mounted, the wall is membranous, dark brown, black round the ostiolum, the outer layer somewhat amorphous and bearing a few adherent dark-brown hyphae, 3 μ diameter. The spores are brown in mass, yellow-brown to almost hyaline when viewed separately, smooth, oval, 3·5-5 ×2-2·5 μ or globose, 3 μ diameter.

This is apparently *Coniothyrium*, and will stand as *Coniothyrium Lobeliae* (B. & Br.). But it would appear probable that the fungus is merely saprophytic, and is not peculiar to *Lobelia*.

314.—**Phoma hysterioideum** B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 803, as " Ellipticum, nigrum, epidermide cinctum, opacum ; sporis oblongis minimis (No. 509). Possibly a state of *Dothidea graminis*. " In Herb. Peradeniya, Thwaites 509 and 733, on *Panicum fluitans* are included under *Dothidea graminis*. Berkeley and Broome cited Thwaites 733 for the latter species, but not Thwaites 509. There is no specimen under the name *Phoma hysterioideum* in Herb. Kew, but Herb. British Museum has a specimen *ex* Herb. Broome, labelled by Thwaites " 509, *Phoma* on *Panicum fluitans*, " with a drawing by Broome which shows an ascus and spores.

The stromata appear as black, slightly elevated, oval spots, up to 0·6 mm. long and 0·35 mm. broad, scattered over the upper surface of the leaf : they are not evident from the lower surface. The stroma is about 0·2 mm. thick, covered by the cuticle, or the outer wall of the epidermal cells of the host, and extending in the mesophyll down to the

vascular bundles. The wall is black and dothideoid at the sides and over the top, with a thin, brownish basal layer. The sides expand towards the base, and may attain a thickness of 50 μ there. Only one loculus, laterally oval, is seen in transverse section, as a rule. In some cases, however, two loculi appear, but these are separated by a black wall, and most probably are cross sections of two confluent stromata. The loculi contain asci, which are clavate, 80 × 16 μ, or broadly clavate, 64 × 20 μ. The spores are hyaline, ellipsoidal, continuous, 10-14 × 6-8 μ. Numerous linear paraphyses are present.

In all the stromata examined, the loculi contain minute, hyaline, oval spores, 2-3 × 0·5-0·75μ. or less. These are situated above the mass of asci and paraphyses, and are probably derived from the latter. No case was observed in which the loculi contained these spores only; even when they were most numerous, well-developed paraphyses and immature asci were present.

Phoma hysterioideum, consequently, is a pycnidial stage of *Phyllachora graminis* (*sensu lato*), as suggested by Berkeley and Broome. But it is not, from the specimens examined, a true *Phoma*, nor a distinct form of the *Phyllachora*. It is merely a transitory stage in the development of the ascigerous loculus.

315.—**Hendersonia Symploci** B. & Br.

Berkeley and Broome's description of this species in Fungi of Ceylon, No. 794, is "Peritheciis nitidis, saepe circinantibus; sporis fusiformibus triseptatis (No. 592). On *Symplocos obtusa* Wall. Central Province, 5000 ft. Spores ·00012 long. No. 455 is a doubtful species of the same genus." In Herb. Peradeniya, Thwaites 592 is labelled Nuwara Eliya, and 455, Central Province.

There are two species in Thwaites 592, on leaves of *Symplocos obtusa*. One, the more numerous, has minute shining stromata, often arranged in circles, with no evident discoloration of the leaf. The other has rugose, dull black pycnidia on circular discoloured spots.

The latter fungus causes circular spots, purple-brown or black-brown, often concentrically zoned, slightly raised, about 1 mm. in diameter. In the middle of these spots there arises a single pycnidium, flattened globose, rugose, black, 0·5 mm. diameter, or a group of two or three globose pycnidia, about 0·25 mm. diameter. The pycnidia break through the surface of the spot, and become almost superficial, surrounded by the ruptured epidermis. Ostiola are not evident. The upper part of the wall of the pycnidium is thick and almost carbonaceous, and in sections it splits away in manner suggestive of the Leptostromataceae, but that does not appear to occur naturally. The spores are rather pale

brown, fusoid or cylindric, ends obtuse, three-septate, not constricted, collapsing, 22-32 × 4-6 μ. The basidia are short.

The second species is common at Hakgala on *Symplocos* spp., and has been collected on *Symplocos elegans*, *S. obtusa*, and *Symplocos latiflora*. The stroma are minute, up to 0·25 mm. diameter, subcuticular, broadly conical, with a flat base overlying the epidermal cells. They occur on either side of the leaf, frequently arranged in circles, and are black and shining, not erumpent, The upper layer, or cover, is black, opaque, up to 50 μ thick ; the basal layer is black and thin, 4-16 μ thick. The thin edge of the stroma is usually opaque, but it may extend laterally for some distance, underlying the cuticle and appearing from above as a sheet of laterally-united, radial hyphae. The thickness of the stroma in the centre is about 0·1 mm. Each stroma contains a single, laterally oval loculus, the space between the loculus and the margin of the stroma being filled with more or less vertically parallel, brown hyphae. The asci are thick-walled, clavate or subcylindric, 90 × 16 μ, eight-spored, spores biseriate. They are embedded in a tissue of thin, parallel, adherent, hyaline hyphae. The spores are brown, fusoid or oblong-oval, with obtuse ends, three-septate, sometimes scarcely constricted, sometimes so strongly constricted at the median septum that they readily separate into two, 15–20 × 4–5 μ. The asci are soon diffluent, and in very many cases only the spores are found in the loculus.

Berkeley and Broome's description evidently includes both species. The spores described are, from their size, those of the pycnidial fungus, while the phrases, " Peritheciis nitidis, saepe circinantibus " refer to the ascigerous species.

Pending the full revision of the Sphaeropsidales, the first species may be left under Berkeley and Broome's name, *Hendersonia Symploci*. The second is a *Dermatodothis*. which has been named *Dermatodothis zeylanica* Syd.

Thwaites 455 is *Dermatodothis zeylanica*.

316.—**Hendersonia constricta** B. & Br.

Berkeley and Broome's description of this species in Fungi of Ceylon, No. 795, is " Peritheciis subglobosis pruinatis, basi floccis radiantibus suffultis; sporis metulaeformibus uniseptatis, medio constrictis (No. 351). On dead wood. Spores ·0009 long. " Saccardo, in listing it in Sylloge, III, p. 442, added " An Diplodiella ? an Staganospora ?". There is apparently no specimen in Herb. Kew. The type is in Herb. British Museum.

The wood is covered with a dense weft of dark brown, fairly regular, septate hyphae, forming a somewhat compact layer about 0·5 mm.

thick. The perithecia are embedded in this layer and are not visible to the naked eye. They are globose, 0·2 mm. diameter, or vertically oval, 0·3 mm. high, 0·2 mm. broad. The hyphae in which they are embedded arise both from the substratum and from the wall of the perithecium. The latter is thin and fragile, and consists of an outer brown layer of large cells,up to 16 μ broad, and an inner hyaline layer. The spores are pale fuliginous,narrow-oval or oblong-oval, ends rounded, one-septate, constricted at the septum, 16-26 × 6-8 μ. Most of them lie loose in the perithecium, but they are undoubtedly ascospores, and remains of the asci with included spores are present.

This species is *Neopeckia*, and will stand as *Neopeckia constricta* (B. & Br.).

317.—Sphaeropsis annularis B. & Br.

Myrosporium rufum B. & Br.

In Fungi of Ceylon, No. 792, Berkeley and Broome described *Sphaeropsis annularis* B. & Br., "Lateritia, peritheciis centro depressis; sporis subcuneiformibus (No. 114). On dead wood, Nov. 1867. Looks like a collapsed *Nectria*; spores ·0005 long." In Saccardo, III, p. 615, it was listed as *Zythia annularis* (B. & Br.).

In Fungi of Ceylon, No. 793, *Myrosporium rufum* was described It was "Placentaeforme, rufum, nitidum, collabens; sporis subellipticis (No. 1016). On petioles apparently of some palm. Peradeniya, Dec. 1868. Looks at first sight like a collapsed *Hypocrea*. About half a line broad; spores rather variable in form, elliptic, obovate, or subcymbiform, ·0005–·0006 long, ·0004 wide. It seems to come nearer to Corda's genus than any other. Had the perithecium been black, it might rather have been referred to *Coccularia* Cd." In recording this species in Sylloge Fungorum, III, 619, Saccardo stated "Sec. Berk. ad Myrosporium Corda propius accedit, quod vero genus est Myxomyces, teste Frieso," and, from the description, he placed it in *Aschersonia*, as *Aschersonia rufa* (B. & Br.).

In Herb. Peradeniya, Thwaites placed his Nos. 114 and 1016 on the same sheet, evidently regarding them as the same species, as they undoubtedly are.

The stromata are very variable in appearance. The smallest are about 0·4 mm. diameter, evenly pulvinate, dark red brown to almost black. Others are dark red brown, or purple black, placentiform, tuberculate at the margin and depressed in the centre, 1·5 mm. diameter and 0·3 mm. thick: while the largest are irregularly tuberculate, up to 4 mm. in diameter and 1·5 mm. high, with the same variation in colour. They look like groups of collapsed Nectrias, or like a small Tremellaceous fun-

gus, being rather hard, glabrous, slightly subtranslucent, and appearing as if subgelatinous when fresh. In spite of the variation in colour macroscopically, they all present the same appearance in sections by transmitted light. The interior is pale yellow, becoming red brown towards the exterior, with a deep red brown, or blackish brown, outer layer.

At the base of the stroma is a layer of hyaline hyphae, 3 μ diameter, forming a thin, rather loose, plectenchymatous tissue. Above this the fungus appear to consist entirely of oval or globose spores, pale yellow, thick-walled, minutely verrucose, 9–16 × 8–10 μ. On staining and examination with a high magnification, slender hyphae, about 1·5 μ diameter, are found between the spores. The spores appear to be borne laterally on the hyphae. The outer red brown layer consists of agglutinated spores and fine hyphae.

The fungus is apparently a Hyphomycete, belonging to the *Tuberculariaceae*. There appear to be several genera in which it might be placed, but most of them are insufficiently known. It would seem that it might be included in *Illosporium*, judging from the descriptions of species which have been placed in that genus. It will then stand as *Illosporium annulare* (B. & Br.).

318.—Sphaeropsis Diospyri B. & Br

This was described by Berkeley and Broome in Fungi of Ceylon, No. 790, as "Nitida, congesta, incarcerata, epidermidem elevans; sporis magnis; paraphysibus longis (No. 1131). On fruit of *Diospyros embryopteris*. Peradeniya, Dec. 1868. Spores ·001 long."

Part of Thwaites 1131 is in Herb. Peradeniya. "Nitida" can only refer to the epidermis of the *Diospyros* fruit. The epidermis is raised in numerous, rather close-set, pulvinate elevations, either circular, 0·7 mm. diameter, or oval, 1 × 0·7 mm., and ultimately splits, usually longitudinally, over them. Beneath each elevation is a black stroma containing numerous pycnidia. The pycnidia are rather loosely bound together, and separate in free-hand sections. They are up to 0·3 mm. diameter, with separate ostiola, up to 40 μ diameter. The majority of the spores are immature, but dark brown, oval, one-septate spores, 26 × 14 μ have been found. Long paraphyses are present.

The fungus is *Botryodiplodia*, and will stand as *Botryodiplodia Diospyri* (B. & Br.). Morphologically it is identical with *Botryodiplodia Theobromae* Pat.

319.—Sphaeropsis anomala B. & Br.

The description of this species, in Fungi of Ceylon, No. 788, is "Maculis minutis aterrimis rugosis, peritheciis confusis; sporis obvatis e stipite

brevi articulo divisis, demum uniseptatis (No. 481). On *Artocarpus Lakoocha* var., Peradeniya, Jan. 1868. Spores ·0013 long." In Saccardo, III, p. 300, the spores are given as 30–32 μ and the habitat " In ramis *Artocarpi Lakoochae* ;" and it is suggested that the fungus may be a *Diplodia*.

The specimen, Thwaites 481, in Herb. Peradeniya is a leaf of *Artocarpus Lakoocha*, not a stem. The fungus occurs on the upper surface of the leaf in the form of minute, black, superficial pycnidia. These pycnidia are circular or oval in plan, up to 0·5 mm. diameter, sometimes confluent, conical with a flattened margin. The surface is rugose and the margin radially sulcate. Ostiola have not been observed, but in the majority of cases the apex of the pycnidium appears to have been damaged. By transmitted light,the wall of the pycnidium is opaque, except at the margin, which is dark brown, composed of parallel radial hyphae. The pycnidium is multilocular. There is no external mycelium, but the pycnidium arises from a hypostroma, about 20 μ thick and up to 200 μ diameter, embedded in the epidermis of the leaf. The spores are pyriform or turbinate, usually truncate at the base, or ovoid, truncate above and below, black-brown, ultimately opaque ; they are borne on hyaline, cylindric pedicels, 16–26 × 4–5 μ, inflated below, which are often persistent. The spores have a single transverse septum at about one quarter the length of the spore from the base, and the upper loculus is usually strongly guttulate ; they measure 24–32 × 12–17 μ.

This species is a pycnidial form belonging to the Dothideales. It appears to agree well with *Peltistromella*, and will stand as *Peltistromella anomala* (B. & Br.).

320.—Sphaeropsis seminicola B. & Br.

Berkeley and Broome's description of this species, in Fungi of Ceylon, No. 791, is " Minuta, gregaria, libera, setis rigidis sparsa ; sporis oblongis obtusis (No. 1132). On seeds of *Artocarpus integrifolia*. Peradeniya, Dec. 1868. Spores ·0005 long." In Saccardo, III, p. 220, it was listed as *Pyrenochaeta seminicola* (B. & Br.) Sacc.

The specimen, Thwaites 1132, in Herb. Peradeniya, bears minute, irregularly circular, black spots, up to 0·2 mm. diameter, sometimes confluent. These prove to be subepidermal acervuli, which subsequently rupture the overlying epidermis, but do not open widely, as far as this specimen shows. The conidia are hyaline, cylindric with rounded ends, 12–18 × 3–4 μ. Some acervuli do not bear any setae, and are *Gloeosporium*. Others have numerous setae, and are *Colletotrichum*. In this specimen, however, the setae have been broken or bitten off, and only the bases are left in the acervuli, with fragments scattered over the host

tissue. They are dark brown, up to 7 μ diameter below, slightly expanded at the base, and have acute tips. Complete setae have not been observed.

There are also present on the specimen some loose spores of a *Melanconium*, brown, oval, lenticular, with a pale edge, 8 × 4 μ.

Berkeley and Broome's fungus is a *Colletotrichum*, which will stand as *Colletotrichum seminicolum* (B. & Br.).

321.—Diplodia Cathartocarpi B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 787, as " Peritheciis congestis e macula pallida oriundis minutissimis epidermidem elevantibus, ostiolo latiusculo ; sporis oblongis utrinque subalternatis (No. 525). On either surface of leaves of *Cassia fistula*, Damboul, Feb. 1868. Spores ·0005–·001 long by ·0002 Besides there are minute conidia ·00015–·0002." In Saccardo. III. p. 337, " subalternatis " was altered to " subattenuatis."

The specimen, Thwaites 525 in Herb. Peradeniya, is marked by Thwaites " on *Cassia Fistula*. Damboul." The leaves bear minute black spots, up to 0·25 mm. diameter, crowded together, on both sides of the leaf but chiefly on the lower. These black spots are parenchymatous sub-epidermal stromata. The epidermis ruptures in several places over each stroma, and a dense cluster of dark-brown, septate conidiophores, each about 20 μ high and 3·5 μ diameter, emerges. The initial perforation of the epidermis is usually circular, and these holes constitute the wide ostiola of the description. Conidia have not been observed *in situ* on the tufts, but large numbers of detached spores lie on the surface of the leaf. The spores are subcylindric, fusoid, or narrow-oval, pale fuscous, one-septate, often constricted, slightly attenuated or rounded at the ends, 16–19 × 4–5 μ. It is probable that these spores belong to the conidiophores, but the problem is complicated by the presence of an ascomycete, with thick-walled asci, 60–72 × 12–14, the immature spores of which (in the ascus) are narrow-oval or subfusoid, hyaline, one-septate, 14–17 × 3–4 μ. There are also, as noted by Berkeley and Broome, hyaline, oval or subglobose spores, 6–7 × 4–5 μ, apparently of a *Phoma*.

The principal fungus on the specimen is a *Fusicladium*. The leaf is not *Cassia Fistula*, but quite evidently *Pongamia glabra*. And the fungus is *Fusicladium Pongamiae* Syd. The name *Diplodia Cathartocarpi* may consequently be discarded.

322.—Diplodia circinans B. & Br.

In Fungi of Ceylon, No. 786, Berkeley and Broome described *Diplodia circinans*, as " Peritheciis circinantibus epidermide nigrifacta centro

pallido tectis ; sporis brevibus ellipticis obtusissimis (Nos. 356, 357). On *Yucca gloriosa*. Perithecia two to three under each spot ; spores ·001 inch long, ·0005 wide." They added "No. 358 is a variety with the pustules more scattered, but without fruit." In Saccardo, III, p. 371, the fungus is said to grow on *Yucca gloriosa* in Ceylon and *Yucca aloifolia* in North America. The latter record is from Berkeley's Notices of North American Fungi, Grevillea, III. p. 3, "*Diplodia circinans* B. & Br. var. *diffusa*. On *Yucca aloifolia*. No. 660. Also in Ceylon."

In Herb. Kew, Thwaites 356 is marked *Diplodia circinans* ; Thwaites 357, *Diplodia circinans* var.; and Thwaites 358, *Diplodia circinans* var. *diffusa*. They are all from the same locality, Nuwara Eliya.

In Thwaites 356, the leaf bears minute, oval, black rings, up to 0·4 × 0·3 mm., with a white centre, often confluent in twos or threes. The black ring is up to 0·1 mm. broad. These rings are arranged in concentric ovals, up to 2 × 1 cm., with others irregularly scattered. In section it is found that under each minute ring there is situated a flattened parenchymatous stroma, brown at the sides but hyaline in the interior. The brown coloration does not extend over the upper surface, and hence the stroma causes a black ring with a white centre on the overlying epidermis. The stromata in No. 356 appear to be solid and sterile.

In Thwaites 357, the minute ring spots are scattered, not circinating. They are larger, up to 1·5 mm. diameter, with a broader black ring, and elevated. The stroma ruptures the overlying epidermis, and ultimately crumbles and falls out, leaving a black cavity. Mature stromata are black (dark brown or red brown in section by transmitted light), and contain from one to four perithecial cavities, up to 0·3 mm. diameter. The spores are oval, hyaline, continuous, 20–24 × 8–12 μ. They are evidently ascospores, but the asci are either soon diffluent, or broken in these specimens, and only fragments of them have been observed.

In Thwaites 358, the ring spots are not arranged in any definite order, but they are more crowded than in Thwaites 356. The fungus is in a more advanced condition than in the latter, and the stromata show perithecial cavities, but they are immature.

This fungus is a *Botryosphaeria*. It is apparently identical with *Botryosphaeria Agaves* (P. Henn.) Syd. (*Physalospora Agaves* P. Henn.), but I have not seen authentic specimens of the latter.

323.—Diplodia radula B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 785, as "Peritheciis minutis epidermidem albifactam elevantibus, ostiolis distinctis ; sporis ellipticis (No. 305). On Musaceae.

Spores ·001 inch long, narrower than in the next spcies (*i.e. Diplodia circinans*), dark, with a wedge-shaped pedicel."

In recent specimens, on decaying leaf stalks of plantains, the pycnidia are 0·2–0·3 mm. diameter, scattered or clustered, immersed, elevating the epidermis in minute, white points. The spores are ellipsoid or oblong-oval, not constricted at the septum, 24–28 × 11–14 μ. The basidia are short and stout, up to 16×5 μ, sometimes attenuated upwards. Numerous linear paraphyses are present, up to 100 μ long and 2 μ diameter.

Grove, in Kew Bulletin, 1921, p. 143, suggests that this species is identical with *Macrophoma Musae* Berl. and Vogl., and possibly with *Botryodiplodia Theobromae* Pat. In spores and paraphyses it is indistinguishable from the latter, but the basidia appear to be stouter. It is, however, quite different from *Macrophoma Musae*, which has prominent stromata crowded on the living green tissue and making it appear rough. *Macrophoma Musae*, in the specimens collected in Ceylon, does not develop into a *Diplodia*.

324.—Diplodia zeylanica Tassi. **Diplodia striata** Tassi. **Diplodia Hurae** Tassi

In Bull. Lab. Ort. Bot., Siena, II, (1899) p. 154, F. Tassi described *Diplodia Hurae*, on seeds of *Hura crepitans*, and *Diplodia striata* on seeds of *Tectona grandis*, both from Ceylon; while in vol. III of the same journal, (1900), p. 19, he added *Diplodia zeylanica* on seeds of *Cyathocalyx zeylanicus* from Ceylon.

Diplodia zeylanica had pycnidia scattered or gregarious, 0·5–1 mm. diameter; spores, 25–26×12 μ; and numerous paraphyses, three or four times as long as the spores.

Diplodia striata had pycnidia, 0·3 mm. diameter; and spores, 18–20 × 12 μ, longitudinally striate. Paraphyses are not mentioned.

Diplodia Hurae had pycnidia 0·3 0·5 mm. diameter; and spores, 24–26 × 12 μ. The description does not refer to paraphyses.

The common *Diplodia* on decaying seeds or fruits in Ceylon is *Botryodiplodia Theobromae* Pat. In the case of dehiscent fruits which have a certain amount of pulp between the seeds, *e.g.*, *Cullenia excelsa*, this species will develop in abundance between and on the surface of the seeds, if the fruit is prevented from dehiscing completely when ripe, as is usually done with museum specimens. From the description, it would appear most probable that *Diplodia zeylanica* is identical with *Botryodiplodia Theobromae*. With regard to the other two species, the dimensions of the spores would not exclude them from *Botryodiplodia Theobromae*, but the descriptions do not mention paraphyses. As, however, very many

of the descriptions of *Botryodiplodia Theobromae* have been similarly deficient, the types of these two should be re-examined with that point in view.

325.—Pestalozzia congesta B. & Br.

In Fungi of Ceylon, No. 805, Berkeley and Broome described *Pestalozzia congesta* from Thwaites 511, as "Cellulis congestis prominulis brunneis ; sporis oblongis uniseptatis. On underside of leaves of *Syzygium Jambolanum*. Peradeniya, Feb. 1868. Forming little brown patches about a line wide." *Syzygium Jambolanum* DC. is *Eugenia Jambolana* Lam.

In the specimen in Herb. Peradeniya, the leaf bears minute, pulvinate, black elevations, about 0·5 mm. diameter, crowded together in groups up to 2 mm. diameter. The acervular loculi are lenticular, up to 250 μ broad and 100 μ high, on either side of the leaf, but chiefly on the lower, and do not open widely. The spores are borne on stout hyaline basidia, 6–18 μ high, expanding to 2 μ diameter at the apex, and are oval or subcymbiform, rather pale brown, one-septate, usually not constricted at the septum,rounded or truncate below, rounded at the apex, 17–26 × 8–10 μ. At the apex of the spore are from two to four, usually three, hyaline flexuose cilia, up to 32 μ long. There is no apical or basal hyaline cell, and no persistent hyaline pedicel.

When Saccardo listed *Pestalozzia congesta* in Sylloge Fungorum, III, p. 786, he added the comment, "Si conidia vere 1-septata, an novi generis typus ?." Subsequently he instituted the genus *Barklayella* for a one-septate *Pestalozzia* described by Ellis and Everhart, and later altered the generic name, which had been antedated, to *Neobarclaya*. He did not, however, include *Pestalozzia congesta* in his new genus. The Ceylon species is evidently *Neobarclaya*, and will stand as *Neobarclaya congesta* (B. & Br.).

An immature Pyrenomycete, apparently a *Micronectria*, accompanies the groups of acervuli.

Sydow has recorded *Neobarclaya natalensis* on *Eugenia Jambolana* from India.

326.—Gymnosporium confusum B. & Br.

Gymnosporium confusum was described by Berkeley and Broome in Fungi of Ceylon, No. 813, as "Effusum, nigrum ; sporis magnis subglobosis. With *Monotospora fusigera*. Spores ·0001–·0008 in diameter." In Saccardo, IV, p. 245, it was listed as *Coniosporium*. *Monotospora fusigera*, Fungi of Ceylon, No. 891, was said to be apparently on the leaves of some palm.

The fungus in the type is apparently on bamboo. The substratum is covered with a thin black powdery mass, which is composed chiefly of the hyphae and spores of the *Monotospora* intermixed with the spores of the *Gymnosporium*. On scraping off this surface layer, it is found that the *Gymnosporium* forms linear acervuli, up to 5 mm. long, 0·2–0·3 mm. wide, which develop beneath the outer layers of the host tissue and either split them longitudinally, so that the acervulus is bordered by the upturned epidermis, or cut out an oval scale, up to 1 × 0·3 mm.

The spores are biconvex, circular, 16–24 μ diameter, or oval, 17-32 × 14–24 μ, pale brown, thin-walled, minutely granular. There are slight indications of a paler edge, but the spores are not mature enough to show it definitely. It is probable that the spores have been affected by the *Monotospora*.

This species is a *Melanconium*, and will stand as *Melanconium confusum* (B. & Br.). In the formation of a scale, it resembles *Melanconium circumcissum* and *Melanconium Dendrocalami*. The former has smaller spores, but the latter is doubtfully distinct from *Melanconium confusum*.

327.—Gymnosporium lineare B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 814, as " Soris linearibus e cuticula bilabiatis ; sporis obovatis brevissime stipatis (No. 506). On *Andropogon muricatum*, March, 1868. Spores ·0005 long. " The specimen, Thwaites 506 in Herb. Peradeniya, is marked on " *Andropogon muricatus*, Damboul." In Saccardo, IV, p. 243, it is listed as *Coniosporium lineare* (B. & Br.)

Andropogon muricatus of Thwaites is *Andropogon muricatus* Retz., which is *Andropogon squarrosus* L. f. of Flora British India and Flora of Ceylon. It is now known as *Vetiveria zizanioides* Stapf.

The fungus is on the leaves of the grass, on which it forms black linear sori, up to 7 mm. long, on the under surface. The sori are bordered by the upturned tissues of the host, which gape rather widely, and have frequently a strand of the host tissue running along the centre from end to end. The leaf of *Vetiveria* consists of an upper and a lower layer of tissue united by transverse pillars, and thus contains large longitudinal air spaces. The fungus occurs in these air spaces, each sorus being confined to one of them, and it ruptures the thinner lower surface of the leaf. Frequently the rupture occurs along both sides of a vascular bundle, and the tissue containing the vascular bundle then persists as a longitudinal strand.

The spores are black in mass and completely fill the cavity for the length of the sorus. When viewed by transmitted light, they are

blackish-brown, very minutely warted or smooth. They are irregularly globose, quadrangular, or pentagonal, 6-10 μ diameter, with many irregularly oval spores of double that size, 13-16 × 8-11 μ. There are no basidia.

This is evidently an *Ustilago*, somewhat immature, and will stand as *Ustilago linearis* (B. & Br.). It does not appear to be markedly different from *Ustilago occulta* P. Henn, recorded on culms of *Andropogon* sp. from Brazil (1897), in which the spores are said to be 6-8 × 6-7 μ, with a minutely verrucose epispore.

Sydow has described *Ustilago effusa*, on *Andropogon muricatus* from India. It occurred on the leaves, sheaths, and culms. The sori are described as " longe lateque effusis ", and the spores as " minutissime verruculosis, 3·5-5 μ diameter. " The host plant would appear to be the same as the Ceylon species, but from the description the fungus would seem to be different

328.—Gymnosporium circumscissum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 811, as " Maculae oblongae ; cuticula circumscissa ; sporis nigerrimis globosis vel subglobosis laevibus (No. 1050). On bamboo. Peradeniya, Jan. 1869. Spores ·0003 long." In Saccardo, IV, p. 224, it was transferred to *Coniosporium*. Grove, in Kew Bulletin, 1918, p. 174, re-described it as *Melanconium circumscissum*.

The pustules are subepidermal, and the overlying epidermis breaks away as an oval scale when the pustule is mature. Sometimes the scale first splits down the centre, while in other cases it cracks radially into four. The pustules are circular or oval, 0·4-1·2 mm. long, 0·4-0·5 mm. broad. The spores are brown, circular in plan, 6-8 μ diameter, biconvex, with a pale margin which appears as a longitudinal band as the spore rolls over.

Melanconium Dendrocalami Petch has the same habit, but its spores are much larger, 20-24 μ diameter. In all other respects the two are the same.

329.—Oidium gilvum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 895, as " Placentiforme, gilvum ; sporis obovatis e pedunculo tenui moniliformiter oriundo (No. 664). Looks at first sight very like an *Hypocrea* ; often crowded together, a line or more across, rather compact." In Saccardo, it was transferred to *Oospora*.

There are specimens in Herb. Kew and Herb. Peradeniya. The specimen in the latter herbarium consists of five pieces of bark, one of

which bears three minute, brown, placentiform stromata. These stromata are about 1 mm. diameter, and 0·7 mm. thick, compact, with a distinct cortex; they appear to be immature *Hypocrea*. The other four pieces do not bear any of these stromata. All the five pieces have minute white tomentose patches in cracks in the bark, which may be the bases of tufts of a hyphomycete, but nothing definite can be made of them. No obovate spores have been found.

Since Thwaites retained five pieces, only one of which bears brown stromata, one is led to imagine that there may have been present originally a hyphomycete which has since disappeared almost entirely through periodic preservation. Berkeley and Broome's description might then refer partly to the stromata and partly to the hyphomycete. "Placentiforme, gilvum" is a correct description of the immature *Hypocrea*, but the remainder of the description does not apply to anything now present.

Unfortunately the details given are too meagre to enable anyone to decide what the obovate spores were, and hence it would appear preferable to discard the name altogether.

During recent years the name *Oospora gilva* (B. & Br.) has been applied in some countries to the very common pink hyphomycete which develops freely on charred sticks in the Eastern Tropics. As has already been pointed out by Miss Wakefield, that hyphomycete is *Monilia carbonaria* Cooke, and it is probably identical with the conidial stage of *Melanospora erythraea*, described by Möller from Brazil. There is no trace of charring on the type specimen of *Oidium gilvum*.

330.—**Fusidium squamicola** B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 877, as "Luteum, floccis erectis ramosis, sporis oblongis brevibus (No. 441). On leaves of *Clerodendron*. Spores 5-9 μ long." They added the note, "It may perhaps be thought that this is only a morbid condition of the scales. This can be determined only on the spot; but at any rate it is worth recording."

The fungus has been collected recently on leaves of *Clerodendron fragrans*. It occurs on the under side of the leaf and apparently attacks the scales only. It appears first in minute tufts at the edge of the scale, with a few simple stout conidiophores, and subsequently covers the scale with a white loose mass, about 0·25 diameter, consisting of hyphae and conidiophores intermixed. The conidiophores are up to 50 μ high, branched; the branches are opposite, stout below, attenuated upwards, or narrow flask-shaped. The conidia are terminal, solitary, hyaline, narrow-oval or oblong-oval, ends acute, 3-5 × 1·5-2 μ.

Berkeley and Broome's "Luteum" is the colour of the scale. Their specimens are in an early stage, and show minute tufts, up to 100 μ broad and 30 μ high, projecting to the number of three or four from a scale. The conidiophores are simple, or once branched, stout, and obtuse at the apex. No spores 9 μ long have been found in the type; Berkeley and Broome may have measured a developing branch.

This species appears to be *Monosporium*, and will stand as *Monosporium squamicolum* (B. & Br.).

331.—**Sporodum effusum** B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 898, as "Strato atropurpureo effuso; floccis erectis hic illic monilia solitaria vel congregata e processu laterali ferentibus (No. 245). On the petioles of fallen leaves. Spores globose ·002 (inch) diameter." In Saccardo, Sylloge Fungorum, IV, p. 308, it was listed as *Dematium*, the spores being given as 5 μ diameter. On the drawing with the type specimen in Herb. Kew the spore is said to be 0·0002 inches.

The type specimen is on bamboo. The fungus forms dark purple-brown effused patches spreading over several centimetres. In the herbarium specimen, these patches are flattened, and consist of sheets of interwoven or depressed hyphae, 0·3 mm. thick. The basal layer is superficial, compact, 50—80 μ thick, and from this there arise flexuose, purple-brown hyphae, simple or branched, up to 200 μ long, 3-4 μ diameter, equal, septate, rather thick-walled, minutely verrucose. These hyphae bear short lateral branches at wide distances, either simple, oval, about 8 μ long, or elongated, one septate, constricted at the septum, up to 25 μ long. The conidia are borne in clusters at the apices of the short branches or at the apices of the long hyphae, and are globose, 3-4 μ diameter, red-brown, minutely verrucose.

This species is a *Trichobotrys*, and will stand as *Trichobotrys effusa*. Except in colour, it does not appear to differ from *Trichobotrys pannosa* Penz. and Sacc., judging from the figure and description of the latter. The colour of *Trichobotrys pannosa* was said to be "ex olivaceo nigricans."

332.—**Mesobotrys graminicola** (B. & Br.) Sacc.

Coniosporium cinctum (B. & Br.) Sacc.

In Thwaites 505, on *Andropogon*, Berkeley and Broome found two species, *viz.*, *Sporodesmium tessarthrum* B. & C., and *Chaetopsis graminicola* B. & Br. Another specimen on *Andropogon* was subsequently sent by Thwaites (No. 1140) and was marked by him, "sent before with No. 505," but Berkeley and Broome recorded it as *Gymnosporium cinctum* B. & Br.

Sporodesmium tessarthrum was originally described from Cuba. It was recorded for Ceylon in Fungi of Ceylon, No. 808, on *Andropogon*, March 1867 (Thwaites 505).

Chaetopsis graminicola B. & Br. was described in Fungi of Ceylon, No. 810, as " Sporis globosis quaternis laevibus (No. 505 in part). On leaves of *Andropogon*. Main filament subulate, articulated, dark below, nearly hyaline above ; spores globose, four together at the tips of the lateral basal threads. Habit exactly that of *Chaetopsis Wauchii* Grev. " In Saccardo, IV, p. 325, it was transferred to *Mesobotrys*, as *Mesobotrys graminicola* (B. & Br.).

Gymnosporium cinctum B. & Br. was described in Fungi of Ceylon, No. 812, as " Sporis globosis aterrimis, floccis erectis septatis cinctis (No. 1140). On leaves of *Andropogon muricatum*. Damboul, Nov. 1868. Spores ·0002 in diameter. Exactly the habit of *Excipula* ; but the spores are totally different and resemble those of *Gymnosporium*." In Saccardo IV, p. 243, it was listed as *Coniosporium cinctum* (B. & Br.). with the suggestion that it might be *Myrothecium* or *Chaetostroma*.

In Herb. Kew, Thwaites 505 is included under *Spegazzinia tessarthra* ; there is no specimen of *Chaetopsis graminicola* so labelled, but the *Spegazzinia* specimen contains both species. In Herb. British Museum the converse holds ; Thwaites 505 is included under *Mesobotrys graminicola*, with Broome's drawing, is marked " *Chaetopsis graminicola* growing with *Sporodesmiun tessarthrum*, " and contains both species.

The specimen of *Gymnosporium cinctum* in Herb. Kew is. as already stated, marked by Thwaites, " sent before with No. 505."

The species assigned to *Sporodesmium tessarthrum* B. & C., now known as *Spegazzinia tessarthra* (B. & C.) Sacc., appears to be correctly named. But *Chaetopsis graminicola* and *Gymnosporium cinctum* are identical, as Thwaites suggested.

Chaetopsis graminicola is superficial, forming black, oval or irregular patches up to 2·5 mm. long and 0·5 mm. wide, which consist of a purple-brown, or black, pulverulent basal mass from which arise numerous rigid, black, erect setae. These setae arise from all parts of the patch and are not confined to the margin ; they are up to 1·5 mm. long, 12 μ diameter below, tapering upwards, regular, black, becoming brown above and sometimes hyaline at the apex, with an obtuse apex, septate, the septa only visible in the lighter coloured parts. The basal layer of the fungus is an irregular, thin network of contorted, olivaceous hyphae, 1·5-3 μ diameter, from which the barren setae arise. Between the setae and arising from the same network are erect, regular, simple, pale brown, or subhyaline, septate conidiophores, up to 75 μ high and 3 μ diameter, which are strongly verrucose and bear conidia apically and laterally.

the conidia are globose, 4-5 μ diameter, or oval, 4-5 × 3 μ. yellow-brown to dark brown, minutely verrucose.

Berkeley and Broome's description, it will be noted, distinguished between the "main filaments," *i.e.* the barren setae, and the "lateral basal threads," which are the conidiophores; but the use of the term lateral was misleading in suggesting that the conidiophores were branches of the setae. They probably meant that the conidiophores were situated at the side of the setae, *i.e.* between them. The conidia occur in groups only by accident after abscission, and they are minutely verrucose under a high magnification.

It is difficult to understand how Berkeley and Broome came to make another species out of Thwaites 1140, especially in view of Thwaites' note. The fungus in the type of *Gymnosporium cinctum* is exactly the same as *Chaetopsis graminicola*, is quite superficial, and though its conidia are black in mass to the naked eye, they are brown by transmitted light. The setae do not surround the patch, but are scattered irregularly through it. The dimensions given by Berkeley and Broome for the conidia agree with those of the fungus examined, and there does not appear to be any other species in the specimen to which Berkeley and Broome's description could be applied.

Gymnosporium cinctum is consequently identical with *Chaetopsis graminicola*. It appears to agree well with *Lacellina* Sacc. (Ann. Myc., XI, p. 418), and will stand as *Lacellina graminicola* (B. & Br.).

333.—**Sporodesmium polymorphum** Cda.

This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 809, from Thwaites 1030, the specimen being on dead wood.

In the specimen in Herb. Peradeniya, Thwaites 1030, the fungus forms thin, effused, compact, black patches. The hyphae or conidiophores are up to 70 μ high and 3–4 μ diameter, black-brown, or dark brown, septate, equal or moniliform, sometimes dividing above into two or three branches. They bear terminal spore clusters, or compound spores in chains, linked by short, septate hyphae, or almost in contact. From one compound spore, three chains of compound spores may arise. The compound spores are black and opaque, irregularly oval, 18–24 × 13–16 μ or irregularly globose, about 18 μ diameter. On heating with lactic acid or caustic potash, they become slightly more translucent, and then separate to some extent under pressure. The individual cells are polyhedral, rounded exteriorly, and 4-8 μ diameter. The compound spore is at first spherical, about 9 μ diameter, divided (in plan) by two diameters at right angles.

This fungus is evidently *Sirodesmium*, and it may be known as *Sirodesmium opacum* n. sp.

334.—Septonema olivaceo-nigrum B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 806, as "Pulvinulis tomentosis olivaceo-nigris congestis; sporis 4-articulatis, articulis globosis, echinulatis e floccis ramosis articulatis oriundis (No. 248). Apparently on leaves of *Agave*. Spores ·0008 long."

This fungus in the type forms lax tufts, about 0·2 mm. diameter, with a pseudoparenchymatous base. These extend and become confluent in purple-black, effused masses. The hyphae are brown or black-brown, 4 μ diameter, regular, rigid, septate, smooth, much branched. The conidia are catenulate, either one-septate, oblong, with rounded ends, strongly constricted at the septum, black-brown, verrucose, 8–11 × 4--5μ, or three-septate, slightly constricted, sometimes only slightly verrucose, 14–28 × 5 μ.

335.—Triposporium Gardneri Berk.

This species was sent to Berkeley by Gardner in 1848, and formed the subject of "A notice of a mould attacking the coffee plantations in Ceylon," in Jour. Roy. Hort. Soc., IV (1849), pp. 7, 8. Berkeley there referred to it as *Triposporium Gardneri* and gave a figure, but he did not publish a description until 1873, in Fungi of Ceylon, No. 894. The description given there is "Olivaceum; floccis fertilibus erectis articulatis, articulis constrictis; sporis 6-8-septate acutis, apice hyalinis. On the under side of dead leaves. July 1848."

In his first notice, Berkeley stated. "The leaves are completely covered with a black sooty wash, and the trees must be in a sad plight; for not only are they smothered with the fungus, but they are weighed down with masses of a gelatinous lichen belonging to the genus *Collema* or some closely allied group, which, though merely forming small radiated black specks when dry, on the application of moisture instantly swells and increases immensely in volume. Mr. Gardner's observation that the fungus is always preceded by an insect is exactly in accordance with what often takes place in similar affections here."

Gardner wrote a "Report on the Brown Scale, or Coccus, so injurious in the coffee plants in Ceylon," in which he referred to the fungus as an *Antennaria*, and gave figures. This appeared in Hooker's London Journal of Botany, II (1850), pp. 353-360, and III (1851), pp. 1-9; and was re-published in Ceylon in 1885. Gardner stated "As certainly as

the scale never appears on the upper surface of the leaf, so surely does the *Antennaria* or fungus never appear on the under one."

The fungus occurred on living leaves, and on the upper surface. The type specimen shows the usual accumulation of species found on the upper side of smooth leaves, *e.g.*, *Cinnamomum ovalifolium*, following scale insects, in up-country districts. The black specks referred to by Berkeley are an *Atichia*, probably *Atichia Millardeti*, which frequently occurs in such situations, and there is also a Trichopeltaceae present. The mycelium on the leaf forms a thin membrane, consisting of a network of olivaceous hyphae, 5–12 μ diameter. The hyphae are verrucose, regular, or closely septate, constricted at the septa and moniliform. The conidia are scanty and often broken; the arms of the spores now present are up to 64 μ long, 14 μ diameter at the base, with septa 12–16μ apart, sometimes even, sometimes strongly constricted and moniliform. Berkeley's figure shows the arms nine times as long as broad, with a hyaline, non-septate tip, up to one-third the length of the arm. The specimen is not now in good condition, and probably the larger spores have been brushed off. Berkeley stated that the spores were sometimes elongated at the apex and proliferous, and he figured that condition. It would seem probable that the latter figure represents mycelium only.

Gardner's figures show only mycelium. His figure 14, "a branch bearing seeds," is a hypha with a foreign body attached to it.

336.—Arthrobotryum curvulum (B. & Br.) Sacc.

This species was described by Berkeley and Broome under the name *Graphium curvulum* in Fungi of Ceylon, No. 901. The brief description is "Sporis curvulis elongatis 6–7 septatis." It was Thwaites 342 and was said to occur on bark with *Thelephora pedicellata*. In Saccardo, Sylloge Fungorum, IV, p. 629, it was listed as *Arthrobotryum*. Thwaites 342 provided the specimen which was recorded in Fungi of Ceylon, No. 574, as *Thelephora pedicellata* Schw.

There is no specimen marked *Graphium curvulum* or *Arthrobotryum curvulum* in Herb. Kew or Herb. British Museum. Thwaites 342 was apparently included under *Thelephora pedicellata* only.

An examination of the specimen, Thwaites 342, in Herb. Kew and Herb. Peradeniya has failed to disclose any *Arthrobotryum*. The hair-like pillars which fringe the stroma are, of course, the pillars of the *Septobasidium* (*Thelephora*). Among the hyphae of the stroma, however, there occur a few hyaline, elongated, septate spores which are undoubtedly the conidia of a *Microcera*, and it would seem probable that these spores provided the description of *Graphium curvulum*. It will be noted that Berkeley and Broome did not describe anything except the spores.

"*Septobasidium pedicellatum*" is parasitic on colonies of scale insects. It frequently happens that some of the insects have been previously killed by *Microcera*, *Tuberculariа*, etc., and in that case the *Septobasidium* grows over scale and fungus alike, the fructifications of the *Microcera* generally penetrating the *Septobasidium* if only the basal layer of the latter has been developed. I have not been able to find the synnemata of *Microcera* in Thwaites 342, but there can be little doubt that that has happened in this case. As it is not possible to decide to which *Microcera* the conidia belong, the name *Arthrobotryum curvulum* should be discarded.

337.—Dinemasporium gelatinosum B. & Br.

This was described by Berkeley and Broome in Fungi of Ceylon, No. 797, as "Superficiale, in epidermide nigra insidens ; sporis hyalinis magnis fusiformibus ellipticisve (No. 556). On dead twigs. Central Province, Feb. 1868. Spores ·0013 long."

In the specimen, Thwaites 556, in Herb. Peradeniya, the fungi are on pieces of a dead twig, and each arises from a small black spot. The spores agree in general shape with those of *Chaetospermum tuberculariοides* Sacc. (=*Tuberculariа chaetospora* Pat., Bull. Soc. Myc. France, IV, p. XL), and, Berkeley and Broome's description making no mention of the appendages, it was re-described in Ann. Perad., VI, p. 255, as *Chaetospermum gelatinosum* Petch. It will now stand as *Chaetospermum gelatinosum* (B. & Br.) Petch. The following description, based on fresh specimens, is repeated from Ann. Perad., *loc. cit.*

The sporodochia are subgelatinous, cylindric, up to 0·6 mm. high, 0·4 mm. diameter, with the base immersed in the substratum. The outer layers are composed of parallel hyphae, 3 μ diameter, which form a sheath and become gelatinous. The inner hyphae terminate as simple conidiophores, up to 30 μ high, 3 μ diameter, with terminal conidia, and are mixed with paraphyses, up to 80 μ long, 2 μ diameter, slightly thickened at the apex. The conidia are oval, inequilateral, or subcymbiform, hyaline, with granular contents and a stout wall, 1·5 μ thick, and measure 36–44 × 16–21 μ. At each end of the spore there is a tuft of six to twelve filaments, up to 80 μ long and 1 μ diameter, while along the more convex side of the spore are short filaments up to 10 μ long, or capitate appendages up to 4 μ long.

338.—Stilbum stromaticum Berk.

This species was described by Berkeley in Hooker's London Journal of Botany, II (1843), p. 642, from specimens collected by Gardner in Brazil, the description being, "gregarium, e stromate nigro inaequali ;

stipitibus compressis striatulis nigris ; capitulis aureis globosis ; sporis minutissimis subglobosis. Forming effused patches on the bark, springing from a black, smooth, undulated stroma, which has exactly the structure of a Sclerotium, consisting of angular cells, each of which contains a nucleus, those of the cuticle being darker and smaller. Stems distinct, 1·5–3 lines high, 1/8 of an inch thick, compressed, black, consisting of very fine fibres, externally slightly striate, surmounted by a yellow globule, which is coated with very numerous, extremely minute, subglobose spores."

It was subsequently recorded by Berkeley and Broome for Ceylon, in Fungi of Ceylon, No. 866, from Thwaites 1224, collected below Adam's Peak, February 1871. There are specimens of the latter collection at Kew and at Peradeniya. The date on the specimen in Herb. Peradeniya, Thwaites 1224, is February 1870, but it is undoubtedly part of the same gathering as that in Herb. Kew.

Bresadola (*fide* von Höhnel) redescribed the Brazilian species in Hedwigia, 1897, p. 302, which is not at present accessible to me. von Höhnel gave a full description of specimens from the same country in Eumycetes et Myxomycetes, Ergebnisse der Bot. Exped. der kaiserl. Akad. der Wissenschaft. nach Südbrasilien, 1901, and transferred it to a new genus *Stromatographium*, as *Stromatographium stromaticum* (Berk.) v. H.

The Ceylon specimens contain two forms. In the one form, the stromata are superficial, up to 5 mm. diameter, black, thin, glabrous, irregularly furrowed and tuberculate, somewhat fleshy, not brittle, about 200 μ thick, brown internally, parenchymatous, with cells up to 16 × 6 μ. From these arise numerous synnemata, up to 4 mm. high, black, glabrous or minutely pruinose, sometimes longitudinally furrowed, up to 0·15 mm. diameter at the base, tapering to 0·075 mm. diameter at the apex. The heads are now yellow, subtranslucent, about 0·3 mm. diameter. When viewed by transmitted light, it is seen that the stalk terminates in a pale brown zone, while the centre of the head is dark brown. The conidiophores form a translucent zone 50 μ deep round the brown centre ; they are closely crowded, hyaline, filiform, branched, curved above, and bear minute hyaline conidia, either oval, 1·2 × 0·75 μ, or globose, 0·75 μ diameter. The conidia are agglutinated into a solid mass round the head. A few conidiophores are longer than the rest, and project beyond the hyaline palisade zone.

With these are a few other examples which at first sight appear quite different. These are fasciculate, with no evident stroma, or a slight stroma on one side of the group. They are up to 5 mm. high, with flattened stalks, up to 1 mm. broad below, flask-shaped or attenuated up-

wards. The stalk is rough with minute protuberances, especially towards the apex. The head is black, laterally compressed, reniform, 1·2 mm. broad, 0·4 mm. high, descending about 0·3 mm. on either side of the stalk and well defined from it. In section, the centre is pale brown, surrounded by a dark brown zone about 50 μ broad, and an outer compact layer of conidiophores, of about the same breadth. The conidiophores and conidia are the same as in the slender examples, but there is a larger number of elongated conidiophores, up to 180 μ long. There does not appear to be any doubt that these are merely larger examples of the same species.

The Ceylon form differs from the Brazilian, judging from von Höhnel's description, only in its thinner stroma. Berkeley evidently correctly referred the two collections to the same species.

339.—Isaria arcyrioides B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 864, as " Stipite nigro sulcato in capitulum clavatum desinente ; sporis metulaeformibus angustis pallidis (No. 122). Spores 12·5–18·75 μ long, one-third as much broad in the centre."

It has been found recently on decaying wood at Hakgala. The surface of the wood is blackened. The synnemata are clavate, up to 2·5 mm. high. The stalk is black, and the head grey, loose, ovoid or cylindric. The stalk in some cases is stout, 0·5 mm. diameter, and its constituent hyphae separate above to form the head; in other cases, it is slender, 0·2 mm. diameter, and is continued above as a columella in the centre of a cylindrical head. The conidiophores are branched, the ultimate branches being long and slender, and about 2 μ diameter, with terminal conidia. The conidia are hyaline or slightly fuscous, narrow-oval, with acute ends, 8-14 × 3–4 μ.

340.—Isaria aurantiaca B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 860, as " Congesta, lateritio-aurantiaca, cylindrica vel compressa, subramosa, radians ; sporis curvis (Nos. 253, 334). On bark and decorticated branches. Nuwara Eliya. Bright orange ; about a line high ; spores 0·0004 long." The second number should be 344. Thwaites 334 is *Grandinia lateritia*, Fungi of Ceylon, No. 561.

No. 253 was collected at Peradeniya on wood, and No. 334 at Hakgala on bark. The two fungi are totally different. No. 253 consists of minute black stromata, with a carbonaceous crust, deep red-brown internally. Some of these are broken and display the colour of the interior, while others bear Stilbum-like processes which may be a coni-

dial stage, or developing ostiola. Nothing matching this has been collected recently. On the other hand, No. 344 has been collected on several occasions during the last fifteen years in the Botanic Gardens, Hakgala, where it is nearly always to be found on some old specimens of *Apodytes Gardneriana*, relics of the former jungle ; it grows on the decaying bark scales of the living trees, not on wood. The description of *Isaria aurantiaca* was apparently drawn up from Thwaites 344, and hence the specific name is retained for the latter fungus. Thwaites 253 is immature and unrecognisable. The following description relates to *Isaria aurantiaca*, Thwaites 344.

The individual clavae are orange yellow, clavate or fusoid, subacute at the apex, about 2 mm. high, 0·4 mm. diameter, more or less tomentose, and rarely forked. They are rather loosely built of hyphae 2–4 μ diameter, which are encrusted with minute yellow granules. They occur crowded together in small clusters, more or less radiating from a centre, or in long lines in cracks in the bark. They arise from a yellow mycelium within the bark, but are very slightly attached and readily fall off. I have examined these clavae on many occasions, but have not been able to find any spores on them.

Arising among the clavae already described there occur others up to 1 cm. high, 0·6 mm. diameter below, greyish yellow, forked at about half their height, the branches forking again into comparatively long, simple, terete, acute tips. This is a *Lachnocladium*. It is composed of hyphae similar to those of the simple fusoid clavae, and all stages between the latter and the fully-developed *Lachnocladium* occur. The spores are white in mass, pale yellow when magnified, smooth, oblong-oval, inequilateral, 7–11 × 3–5 μ. It will be known as *Lachnocladium aurantiacum*.

The simple barren clavae occur in large numbers, but the fully-formed *Lachnocladium* is comparatively rare. There is no evident reason why the barren clavae should be produced in such profusion, and no similar case appears to have been recorded with regard to any other species of *Lachnocladium*.

341.—Isaria pulcherrima B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 863, as " Alba, clavata, deorsum filiformis, villosa, e mycelio byssoideo quandoque repente oriunda, floccis fertilibus articulatis : sporis ex articulis enatis verticillatis (Nos. 219, 249). On fruit and leaves of palms. Sometimes scattered, sometimes crowded ; spores subglobose, ·00015 (inch) long." They gave figures, showing the conidia arranged in rings round the conidiophores.

In the type specimen, the synnemata are white or cream-coloured, up to 1·5 mm. high, scattered or somewhat clustered. Each arises from a small circular byssoid patch, and these patches may be confluent, but the "somewhat repent mycelium" noted by Berkeley and Broome consists rather of decumbent and weathered synnemata. The head is cylindric, about 0·4 mm. diameter and one-third the total height, or shorter and clavate. The stalk is about 0·1 mm. diameter, loosely fibrillose externally, with hypha of the same character as the conidiophores; when mounted, it appears yellow, and is continued almost to the apex of the head as a yellow columella.

The head is composed of rather loosely arranged conidiophores which spread at a small angle from the columella. The conidiophores are thick-walled, 2 μ diameter below, with clavate tips, up to 4 μ diameter; they are closely septate, especially above, where the septa may be only 6 μ apart. The apical cell is more or less ovate, sometimes acute above. The sterigmata are scarcely-elevated protuberances, up to 0·75 μ high; they occur anywhere along the conidiophore, or in a ring just below a septum, or scattered over the terminal cell. I have not seen any as long as those figured by Berkeley and Broome in their figure b. The old conidiophores are verrucose, probably with sterigmata.

The conidia are globose, 3–3·5 μ diameter, or broadly oval, 3 × 3·5 μ, hyaline, thick-walled, minutely verrucose.

Berkeley and Broome's figures are substantially correct. *Isaria cocoa* Lloyd, in Myco. Notes, No. 62, p. 925, would appear to be the same species.

342.—Actiniceps Thwaitesii B. & Br.

The genus *Actiniceps* was established by Berkeley and Broome in Jour. Linn. Soc., XV, p. 85. The description of the genus is "Stipes hyalinus, e floccis congestis in capitulum globosum radiantibus, hic in spiculas conicas vitreas granulatas desinentibus, illic in ramulos tenerrimos; sporae minutissimae." The species, *Actiniceps Thwaitesii*, was said to grow on dead coriaceous leaves, and to have a stem 0·017 (inches) high, and head 0·0065 (inches) diameter, with spicules "more like the parts of a sponge than of a fungus."

Berkeley and Broome gave figures of the entire fungus, the hyphae of the stem, a spicule, and a conidiophore with conidia.

In a part of the type specimen from Herb. Kew examined by me, the stalk is about 220 μ high and 62 μ diameter, slightly expanded at the base, equal, smooth, and composed of parallel thick-walled hyphae. The head is globose, about 0·1 mm. diameter. The spicules arise from, or are in continuation of, the outer hyphae of the stalk. In general, the spicules are broken: they are 8 μ diameter at the base, with an in-

ternal flask-shaped cavity, tapering, and minutely granular. In the centre of the head are the branched bases of the conidiophores, which are also granular. Conidia were not found.

In specimens recently collected at Peradeniya on dead leaves, the stalk is about 200 μ high and 60 μ diameter, pale brown becoming white above. The head is obconoid, about 0·2 mm. diameter, pale yellow. The hyphae of the stalk are thick-walled, but the outer layer is rather loose, and there is frequently a collar on the stalk below the head. All the spicules are marginal, *i.e.* they form a fringe round the lower edge of the head. The spicules are up to 300 μ long and 5 μ diameter at the base, with a minute central cavity, tapering regularly to the apex which is usually obtuse, smooth, thick-walled. The central hyphae of the head (conidiophores) branch repeatedly, all the branches being straight and at an acute angle, and terminating in slender simple basidia. The conidia are rod-shaped or narrow-oval, hyaline, continuous, 4–6 × 1 μ.

Berkeley and Broome's figure is incorrect in showing the spicules scattered over the head. Their specimens were evidently old and weathered, and had lost the looser outer layer of the stem, while their description and figure of the conidiophore and conidia apparently refer to some intrusive mould.

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The genus Cyanotis in Ceylon

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Sir J. D. Hooker, in Trimen's Flora of Ceylon, IV, (1898), p. 311, made the following note. "The species of *Cyanotis* are so very variable in habit and pubescence that probably more Sinhalese specimens than I have had access to are wanted to describe the following species satisfactorily." In view of this statement a large number of Ceylon specimens was collected and examined, and in this examination several errors were found in the descriptions of the Ceylon species. The key on p. 311 of the Flora needs correction in accordance with the differences observed. Only those species which have been wrongly described are re-described below, characters common to the several Ceylon species being enumerated under the generic characters.

Cyanotis Don

Annual or perennial herbs.

Roots fibrous, profuse, usually adventitious at the nodes, turning purple if exposed above the surface.

Stem profusely branched, creeping, decumbent, or erect, usually rooting at the nodes, often differentiated into foliage shoots and flowering shoots.

Leaves alternate, sessile, linear or linear-oblong to lanceolate; base sheathing.

Flowers in axillary and terminal, scorpioid, bracteate cymes, enclosed in more or less falcate, imbricating, biseriate, secund, foliaceous bracteoles, only the petals and stamens exserted; in *C. axillaris* the cymes are reduced to axillary fascicles of flowers within the ochrea.

Sepals 3, connate below, linear-lanceolate to lanceolate-ovate, keeled, persistent, the two interior almost falcate.

Petals 3, united by their claws to form a hyaline tube; lobes spreading. Corolla campanulate or funnel-shaped, soon caducous.

Stamens 6, all perfect, epipetalous: filaments subequal, filiform, contorted in bud, with heliotrope-coloured, moniliform hairs above the middle, fusiform beneath the acuminate tip, except in *C. cristata* and

C. pilosa : anthers basifixed, lobes parallel, oblong, dehiscing from the base along the outer edges : pollen orange-coloured.

Ovary sessile, hairy at the apex, 3-locular with two superposed ovules in each loculus, one erect and the other pendulous. Style linear, fusiform below the apex, naked or bearded. Stigma minute, terminal, punctiform.

Fruit enclosed in the dry cymes within the bracts and bracteoles and the persistent sepals, a very small, dry, oblong, chartaceous capsule, loculicidally 3-valved, usually 6-seeded ; valves loculicidally reflexed from the apex to the base, persistent ; placenta reflexed with the valves (in *C. tuberosa* var. *adscendens* the placenta remains as a central triquetrous column) ; walls brown, smooth, except at the hairy apex, with a well-marked transverse groove along the line of separation of the two seeds of each loculus.

Seeds angular, superposed : hilum almost punctiform, head to head, —if one ovule aborts the hilum is central : embryostega circular, umbonate, horizontal, apical in the upper and basal in the lower seed : testa firm, crustaceous, dark, rarely light coloured, sometimes obscurely vertically striated, on interior or both surfaces foveolate, rugose, or punctate. Embryo under the umbo, parallel to the axis of the capsule, vertical.

In all species, when favourable conditions prevail, vegetative propagation takes place. Except in *C. obtusa* Trim. and *C. tuberosa* var. *adscendens* Clarke, adventitious roots arise at the base of the leaf sheath and pierce it on the side opposite to the leaf. After flowers have been produced the axillary foliage bud grows through the base of the sheath on the same side as the leaf, the main stem dies off, and the branches develop into separate plants. Thus at each node vegetative propagation follows on sexual reproduction. In *C. obtusa* Trim. and *C. tuberosa* var. *adscendens* Clarke, vegetative propagation takes place similarly, except that the vegetative buds arise on the flowering shoots which thus serve as proliferating organs as well.

Key to the Ceylon species of Cyanotis

A. Fl. in scorpioid cymes with large imbricating bracteoles.
  1. Filaments fusiformly thickened below the tip.
    Style bearded.
      Root fibres slender
        Leaves 3-10 in. long, 0.75-1.5 in. broad, glabrous above, plant large — 2. *C. obtusa*
        Leaves 1-2 in. long, 0.2-0.3 in. broad, cobwebby, plant small — 6. *C. fasciculata*

Root fibres stout, ending in cylindrical tubers — 3. *C. tuberosa*

Style naked.

Stem trailing; leaves pubescent with short hairs, or if densely woolly equally pubescent on both surfaces — 4. *C. zeylanica*

Stem creeping below, then ascending; leaves densely woolly pubescent only on lower surface — 5. *C. villosa*

2. Filaments not fusiformly thickened below the tip.

Stem slender; leaves ovate-oblong, 1-3 in. long, 0.5 in. broad, sheath short — 1. *C. cristata*

Stem stout below; leaves linear, acuminate, 2.5-8.5 in. long, 0.17-0.33 in. broad, sheath broad — 7. *C. pilosa*

B. Fl. fascicled, bracteoles concealed in the leaf sheath. — 8. *C. axillaris*

1. **C. cristata** Schultes *f.*, Syst., VII, 1150 (1830); Thw. Enum., 323; Clarke, Mon., 247; Fl. Brit. Ind., VI, 385; Trimen, Fl. Ceylon, IV, 311. Herm., Mus., 53. Burm., Thes., 94. Fl. Zeyl., No. 32. *Commelina cristata* Linn. Sp. Pl., 62. *Tradescantia cristata* Willd., Moon, Cat., 24. Bolhinda, S.

Stem much branched, branches decumbent, lower part purple, upper green: internodes 1-4 in. long, cylindrical, sparsely hirsute or densely and shortly pubescent along a single line reaching from the fused edges of the leaf sheath to the node above. Leaves ovate-lanceolate: sheath 0.5 in. long, green, with distinct purple venation, sparsely hirsute: blade 1.5-3 in. long, 0.4-0.8 in. broad, smooth, hirsute at the colourless margins. Cyme 0.5-0.75 in. long. Bract 2 in. long, 0.6 in. broad, ovate-lanceolate to ovate-cordate, base broadly cordate, amplexicaul, apex acute, colourless, margins colourless, hirsute only towards the apex. Flowers sessile. Sepals linear-lanceolate in outline, acute, boat-shaped and distinctly keeled; margins membranous. Corolla funnel-shaped, lobes semicircular with an acute apex and sinuate margins, light heliotrope. *Filaments not fusiformly thickened.* Style naked, fusiformly thickened at the apex.

Low country; a common weed. Fl. April; heliotrope.

2. **C. obtusa** Trimen, Fl. Ceylon, IV. 312. *C. arachnoidea* var, *obtusa* Trimen, in Journ. Bot., XXIII, 266, and Syst. Cat., 95. *C. arachnoidea Clarke* (in part) Fl. Brit. Ind., VI, 386.

3. **C. tuberosa** Schultes *f.*, Syst., VII, 1153 (1830) var. *adscendens* Clarke, Mon., 249 ; Trimen, in Journ. Bot., XXIII. 173, Syst. Cat., 95, and Fl. Ceylon, IV. 312. Golubellawel, S.

Root fibres stout, ending in cylindrical, fusiform, tubers about 2 in. long, 0.25 in. diameter: about a dozen such tubers to a shoot. Stem differentiated into a foliage shoot and a flowering shoot. Stem of foliage shoot about 1 in. long, enclosed within the sheaths of the leaves. Leaves 8-9 in. long, 0.45 in. at broadest, linear, boat-shaped without a distinct keel, fleshy, stiff, glabrous on the upper surface, hirsute with distinct venation on the lower : margins colourless, ciliate : apex acute : leaf sheaths 0.5-1 in. long, edges fused, dried, brown, the membranous remains enclosing the stem. Flowering shoots 2 or more from the axil of a leaf on a barren shoot, 1-1.5 ft. long, trailing, cylindrical, hirsute, swollen and jointed at the nodes, terminating in a cyme. Leaves of the flowering shoot 1 in. long, 0.25 in. broad, sheath 0.5 in. long, solitary at the nodes. Adventitious roots and one or more foliage shoots arise from the nodes of the flowering shoot. Here the flowering shoots serve also as proliferating organs. Cyme 1.5 in. or more long, curling downwards, resembling a small snail (hence its Sinhalese name), pubescent. Bracts lanceolate, acute, entire, partly sheathing, the upper surface glabrous, the lower hirsute. Bracteoles falcate. Sepals linear-lanceolate, acute, the inner surface glabrous, the outer densely woolly pubescent. Corolla light heliotrope ; lobes broadly ovate, acute. Filaments fusiform. Style fusiform, *bearded.* Ovary densely pubescent.

Damp sandy ground in the dry region ; very rare. Only found at Kirinde, S. Province. Fl. Dec., heliotrope, *not blue.*

Hooker *f.* has the following note in Trimen, Fl. Ceylon, IV, 313, " a most variable plant in habit, foliage, and pubescence. The Ceylon specimens are very poor, much smaller than the Peninsular (from which the description [in Trimen, Fl. Ceyl.] is chiefly taken), and more glabrous, with smaller, nearly sessile cymes. I have not seen the style of the Ceylon specimens. J.D.H." The description given above is from fresh specimens collected at Kirinde in December 1922.

4. **C. zeylanica** Hassk., Comm. Ind., 145 (1870) ; Clarke, Mon., 252 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 313. *C. lanceolata* var. *subglabra* Thw., Enum., 323 ; C.P. 3223, 3216.

Stem cylindrical, trailing, reaching several yards in length : internodes 0·5-3 in. long, deep purple, covered with short glandular hairs. Leaves ovate, 1-2 in. long, 0·5-0·8 in. broad, acute, shortly ciliate towards the margins ; sheath 0·2-0·5 in., strongly hirsute, paler than the blade, with distinct purple veins. Cymes hirsute. Bract 1 in. long, 0·6 in. at widest, lanceolate, base rounded, shortly sheathing, glabrous, acute, margins hirsute. Bracteoles falcate, glabrous, acute. Flower shortly pedicelled. Sepals lanceolate. Corolla lobes broadly ovate, acute. *Filaments fusiform.* Style fusiform, naked.

Montane zone 4-6000 ft., rather common. Fl. Oct-Jan.; purple. Endemic.

5. **C. villosa** Schultes *f.*, Syst., VII, 1155 (1830) ; Clarke, Mon., 251 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 313. *C. lanceolata* Wight, Thw. Enum., 323 in part. C.P. 2332.

Stem stout, cylindrical, creeping below, then ascending, reaching a length of several feet : nodes swollen : internodes about 1 in., purplish red, sparsely covered with long hairs ; from the overlapping edges of the sheathing base of the leaf above to the axil of the leaf below is a line along which the hairs are denser ; some internodes uniformly woolly pubescent. Leaves 1-3·25 in. long, 0·6 in. broad, fleshy, ovate to linear-lanceolate, acute or acuminate, entire ; upper surface glabrous and shining, lower woolly pubescent, green to purplish red ; veins distinct on the lower surface ; sheath usually more densely pubescent than any other part of the plant. Cyme woolly pubescent. Bract very much like a reduced leaf, about three times as long as the cyme. Bracteoles semi-ovate to semi-circular. Flower sessile. Sepals lanceolate-ovate, deeply keeled, glabrous except at the hirsute apex and the margins and keel. Corolla campanulate ; lobes semi-circular, acute. *Filaments fusiformly thickened,* curled like tendrils. Style fusiformly thickened, naked, curled.

Moist region 2-5000 ft.; rather common. Fl. Sept., Oct.

6. **C. fasciculata** Schultes *f.*, Syst., VII, 1152 (1830) ; Thw. Enum., 323 ; C.P. 2433 (*fide* Clarke) ; Clarke, Mon., 253 ; Fl. Brit. Ind.,VI, 387 ; Trimen, Fl. Ceylon, IV, 314.

Stem differentiated into foliage shoots and flowering shoots, floccosely silky or cobwebby. Foliage shoots decumbent and profusely branched, forming groups reaching about 1·5 ft. in length ; internode 0·75-1 in. long, wholly or partly enclosed within the leaf-sheath. Leaf linear, somewhat curved and fleshy, 3 in. long, 0·6 in. at broadest, lower surface paler, upper grooved along the middle, tapering, subapi-

culate, arachnoid. Flowering shoot 3·5-11 in. long, simple or branched, cylindrical, fleshy, arising from the ascending parts of the main stem : roots at nodes only if separated from the rest of the plant ; internodes 1-3 in., cottony pubescent. Leaves of the flowering shoot smaller than, but similar in appearance to, the leaves of the barren shoot. Flowering stalk in the axil of a leaf of the flowering shoot, bearing only a single lateral branch in the axil of a membranous leaf. Cymes shortly stalked, flat, urn-shaped, with or without cottony pubescence. Bracts lanceolate, acute, base plicate, woolly pubescent. Bracteoles falcate, acute, woolly pubescent. Flower almost sessile. Sepals lanceolate, acuminate, outer surface woolly pubescent. Corolla funnel-shaped, lobes broadly spathulate, acute. *Filaments fusiformly thickened. Style bearded* and fusiformly thickened.

Exposed rocky ground in the wet and the dry zones, up to 4,000 ft.; common. Fl. March, Oct.; bright violet blue.

7. **C. pilosa** Schultes *f.*, Syst., VII, 1155 (1830), *non* Wight ; Thw. Enum., 323 ; C.P. 2332 ; Clarke, Mon., 251 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 314.

8. **C. axillaris** Schultes *f.*, Syst., VII, 1154 (1830) ; Thw. Enum , 323 ; C.P. 2330 ; Fl. Brit. Ind., VI, 387 ; Trimen, Fl. Ceylon, IV, 315. *Tradescantia axillaris* L., Moon, Cat., 24.

Stem slender, trailing, reaching about 2 ft. in length. Leaves few, linear, entire, sub-apiculate, glabrous. Several flowers arise in the axil of the same leaf. Flowers ochreate, pedunculate, pale violet-blue. Sepals lanceolate, keeled. Corolla lobes obcordate. Filaments fusiformly thickened. *Style naked*, fusiformly thickened.

Low country in both regions ; common. Fl. March, October.

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Sansevieria zeylanica Willd.

BY

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Brown, in his monograph of the genus *Sansevieria*, (2), p. 227, stated that he had not seen flowers of *S. zeylanica* Willd., and added, "It is remarkable that, although this species was one of the earliest to be described, yet it is one of the least known, or rather is practically an unknown plant to science, since in all modern descriptions, it is inextricably mixed up with the Indian *S. Roxburghiana* and *S. lanuginosa*, and the South African *S. aethiopica*. The confusion was begun by Willdenow himself, who mixed up two other species with this." He also remarked, "I think the specific name *zeylanica* should be exclusively applied to the Ceylon plant, which, with the exception of the living plants now at Kew.....does not appear to be anywhere in cultivation out of Ceylon, nor have I seen in any British or foreign Herbarium good dried specimens that I should unhesitatingly refer to the true Ceylonese plant.....in no single instance have I seen a localised dried specimen from Ceylon."

In the Peradeniya Herbarium there are two sheets labelled *S. zeylanica*. One, from a Kurunegala garden, has no flowers ; it bears the C.P. number 2297 and is probably from Thwaites' collection. The other, also without flowers, was collected by Trimen in January 1888 near Nilgala. Hooker *fil.*, (1) who amplified Trimen's manuscript notes, gives a description of *S. zeylanica*. These notes have been preserved with the Herbarium sheets, and in them Trimen records a description of a Ceylon *Sansevieria*, grown in the Royal Botanic Gardens, Peradeniya, and refers to "a good woodcut" of the plant in the Kew Bulletin of 1887. Brown (2) says that the latter is a figure of *S. Roxburghiana*. Hooker's (1) description is thus very probably of *S. Roxburghiana* and not of *S. zeylanica*, a confusion which might have arisen from an interchange of the labels in the Peradeniya Gardens. The late Mr. van Buuren, at whose suggestion this work was undertaken, told me that plants of *Sansevieria*, obtained from the jungle and transplanted in the Peradeniya Gardens, did not flower even once during the five years he had them under observation. That has been my experience

too, with similar specimens grown in the gardens for the past two years. These observations tend to confirm the suspicion that Trimen's description is that of *S. Roxburghiana*.

The description of *S. zeylanica* Willd. given below is from specimens obtained in the jungle at the foot of Doluwe Kande and from the Anuradhapura district.

Sansevieria zeylanica Willd. Sp. Pl., 11, 159 (1799); Moon, Cat., 25; Thw., Enum., 338. Herm., Mus., 56. Burm., Thes., 11. Fl. Zeyl., n. 130. Niyanda, S. Maral, T.

Stemless. Rootstock creeping, stoloniferous, yellowish white, several feet long. Plants twenty to thirty in a single clump. Leaves 5-12 to a growth, recurved from a little above the middle, erect or ascending; the outer about 2·5 ft. long, 1·3 in. wide at broadest, lanceolate, more or less flat: the inner longer and thicker than the outer: all leaves subapiculate, ending in a sharp brown spine, 0·2-1 in. long, colourless and sheathing at the base for a length of 1-3 in.; both surfaces slightly shining, gland-dotted, and smooth, the lower less so; all leaves with transverse bands of light and dark green merging one into another; margins membranous, colourless or green, turning brownish-red as the leaf ages; the inner leaves in transverse section concave-channelled and very nearly semi-terete; *all leaves longitudinally furrowed on the back*.

Brown (2), p. 226, described the furrows as occurring only on withered leaves of *S. zeylanica*, and used this as a specific difference to distinguish between *S. zeylanica* and *S. lanuginosa* (p. 193).

Inflorescence a scape 13·5-23 in. high, arising from the centre of the plant within the leaves. Scape terete, fleshy, colourless for about 2 in. from the base, then green with reddish green spots: young scapes purple. At distances of 4 and 6·25 in. respectively, are two submembranous sheaths, the lower 0·75-1·6 in. long, and the upper 0·4-0·5 in. long; both sheaths green and glabrous with distinct venation, margins membranous, tapering to a minute, subulate, dark green spine.

Flowers on a minute swelling, in suberect fascicles of 6, which are distant from one another at the lower end, becoming more crowded towards the tapering apex of the scape. The lowest fascicle 7·5 in. from the base. Each fascicle in the axil of a membranous, linear, acuminate bract about 0·5 in. long. Each flower in the axil of a minute, scale-like, ovate, acute bractlet.

Pedicel of each flower about 0·25 in. long, fleshy, jointed near the base; the lower part purple, the upper green. The flower is often deciduous about this joint.

Flower about 0·6-0·9 in. long, 0·2-0·5 in. across, pale greenish-white, somewhat scented.

Perianth lobes 6, united along a third of their length. Each lobe 0·6 in. long, oblong, linear, white with a greenish-white to purple, rounded, boat-shaped, curled apex : base yellow-green.

Stamens 6, epipetalous and opposite the perianth lobes ; filaments tapering ; anthers versatile, sagittate, yellowish-green.

Ovary 0·1 in. long, trilocular, trigonous, smooth, glabrous, with a single basifixed ovule in each loculus ; style about 0·8 in. long, fleshy ; stigma triangular.

Fruit a globose berry, 0·4-0·6 in. in diameter, on a jointed stalk. Only one or two of the ovules are fertilised, and the fruit is either single or bi-lobed accordingly, the sterile loculi persisting as minute swellings at the base of the berry.

Seed creamy-white, broadly ovoid, horny, about 0·25 in. long, with a large yellow patch on the exterior ; embryo small, marginal.

Common in rocky or sandy places in the dry region.

Brown (2), p. 228, says that *S. Roxburghiana* can easily be distinguished from *S. zeylanica*, "for its leaves are mostly shorter, much thinner and consequently less rigid than those of *S. zeylanica*, also of a rather lighter and different tint of green." *S. Roxburghiana* also differs from *S. zeylanica* in that, 1, leaves of the former have green edges which change to white as the leaf ages whereas those of the latter turn to a brownish-red ; 2, the scape of the former has four to five membranous sheaths while that of the latter has only two membranous sheaths ; 3, the flowers of the former arise in groups of about four and of the latter in groups of six.

REFERENCES.

1. Hooker, J. D. in Trimen, Flora of Ceylon, IV (1898), p. 267.
2. Brown, N. E. Monograph of the genus *Sansevieria*. Kew Bulletin, 1915, No. 5, pp. 185-261.

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Plaesianthera

BY

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In Flora British India, Clarke (2), after his description of *Cardanthera Thwaitesii* Benth., wrote, " Possibly a distinct genus resembling *Brillantaisia* except that it is the posterior stamens that are imperfect in this." Trimen (3) stated of the same plant, " Forms a very distinct sub-genus, *Plaesianthera*, Clarke, which ought rather to be considered distinct from *Cardanthera*."

Bentham and Hooker f. (1) gave, among the other characters of the genus *Cardanthera* Hamilt.,

1. Flores ad axillas sessiles v. breviter pedicellati, *solitarii v. plures*, 2-*bracteolati*, v. rarius cymae axillares laxi florae.
2. Calyx 5-partitus, segmentis angustis subaequalibus v. postico majore.
3. Corollae limbus *longe* 2-*labiatus* antico erecto-patente apice 3-lobo infra lobos *saepius* 2-*plicata*.
4. Stamina perfecta 4, *didynama*, *v.* 2 *antica*.
5. Filamentis basi breviter dilatatis.
6. Antherae *oblongae loculis parallelis*.

This enumeration of the generic characters of *Cardanthera* was based upon ten species, including *C. Thwaitesii* Benth., which differs from the other nine as shewn in the table given below.

C. Thwaitesii Benth.	Other *Cardanthera* spp.
1. Flowers solitary in alternate axils.	Flowers spiked or whorled in opposite axils.
2. Bracteoles none.	Bracteoles 2.
3. Calyx 5-partite, segments unequal.	Calyx 5-partite, only the posterior segment larger.
4. Corolla shortly 2-lipped.	Corolla deeply 2-lipped.
5. Corolla palate plane.	Corolla palate transversely plicate-rugose.
6. Stamens 2 ; staminodes 2.	Stamens 4 perfect.
7. Filaments uniform, tapering to the narrow apex.	Filaments dilated at base.

8. Anther lobes subquadrate, united to form an almost horse-shoe shaped anther.	Anthers oblong, lobes parallel.
9. Seeds with slightly curved, strong retinacula.	Seeds with minute, straight retinacula.

In view of these differences, *C. Thwaitesii* should be placed in a genus distinct from *Cardanthera*. Clarke's sub-genus *Plaesianthera* should therefore be given generic rank,

Plaesianthera (Clarke), nov. gen. Acanthacearum.

Herba erecta. Folia opposita. Bracteola nulla. Flores solitarii. Calyx 5-partitus, segmentis inaequalibus. Corollae tubus superne ampliatus ; limbus breviter 2-labiatus, labio postico erecto concavo breviter 2-lobo, antico erecto patente apice 3-lobo. Stamina 2, antica, supra medium tubum affixa ; filamenta non basin dilatata ; antherae subquadratae, loculis non parallelis. Stylus apice linearis ; ovulae in loculis numerosae. Capsula oblongo-linearis. Semina parva, ovata compressa, in retinaculis dilatatis fulta. Monotypic and endemic Genus.

Plaesianthera Thwaitesii (Benth.) Livera, comb. nov.; *Adenosma Thwaitesii* T. And.; *Cardanthera Thwaitesii* Benth., Gen. Pl., II, (1876), 1075.

Caulis erectus, viscidulus, villosus, racemosus ; folia integra, spathulata v. lanceolata, subpetiolata, hirsuta, subtus glabrescentia ; flores solitarii in cymis laxis ; bractea parva. Calyce capsula dimidio brevior.

Roots fibrous, adventitious, the main root being short in most specimens. Stem herbaceous, 4-12 in., erect, pyramidally much branched, terete below, quadrangular above, densely glandular hairy. Leaves numerous, opposite ; on the main stem 1-1.5 in., lanceolate or spathulate; on the branches 0·25-0·75 in., oval ; all obtuse or subacute, faintly crenate, almost entire, tapering to the short petiole, hirsute, paler beneath. Inflorescence a dichasial cyme, becoming sympodial, the upper branches having one branch and one flower suppressed. Pedicel 0·2-0·3 in. long. Bracts like very reduced leaves. Bracteoles 0, calyx 5-partite, lobes linear, unequal, outer surface glandular hairy. Corolla 2-lobed, lobes twisted to left, not transversely plicate. Stamens 2, epipetalous ; anthers introrse, lobes subquadrate, fused at the apex, forming an almost horse-shoe-shaped structure but with the apex more acute. Ovary glabrous. Style sparsely hairy. Capsule 0·25 in.; seeds many, ovoid, compressed ; retinacula conical, slightly curved.

Dry region, rare ; Batticaloa District, abundant ; Karamunai. Fl. March.

REFERENCES.

1. Bentham and Hooker *f.* Genera Plantarum, II (1876), p. 1075.
2. Clarke, C. B. Flora British India, IV (1885), p. 406.
3. Trimen, H. Flora of Ceylon, III (1895), p. 292.

The Jussiaeas of Ceylon

BY

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In his article of the Indo-Malayan species of *Jussiaea*, Ridley (1) mentions Ceylon as the habitat of only *J. erecta* var. *exaltata* Roxb. and *J. speciosa* Ridl. In the Peradeniya herbarium there are sheets of *J. erecta* L., *J. erecta* var. *exaltata* Roxb., *J. villosa* Lam., and *J. speciosa* Ridl. The descriptions given below are from the Ceylon specimens.

Key to the Ceylon Species of Jussiaea.

Stem creeping or floating.	1. *J. repens* L.
Stem erect.	
Plant nearly glabrous ; fruit narrow cylindric	2. *J. erecta* L.
Plant hairy	
Corolla 0·8 in. across ; sepals ovate, acute ; fruit thickly cylindric ; seeds grooved	3. *J. villosa* Lam.
Corolla 2 in. across ; sepals triangular, acuminate, cuspidate ; fruit obconic ; seeds not grooved.	4. *J. speciosa* Ridl.

1. **J. repens** L., Sp. Pl., 388 (1753) ; Fl. Zeyl., n. 169 ; Moon, Cat., 35 ; Thw. Enum., 123 ; C.P. 2793 ; Fl. B. Ind., II, 587 ; Hook. Bot. Misc., III. t. Supp. 40 ; Trimen, Fl. Ceylon, II, 233. Beru-diyanilla S.

2. **J. erecta** L., Fl. Zeyl., 170 ; Sp. Pl., 556 (excluding the S. American plants) ; *J. angustifolia* Lam.; *J. Blumeana* DC.; *J. Junghuhnii* Miq.; *J. suffruticosa* of Clarke and other botanists, not of Linnaeus ; *J. villosa* var. *subglabra* Thw., Enum., 123.; C.P. 1540; *J. suffruticosa* var. *subglabra* (Thw.) Trimen, Fl. Ceylon, II, 233.

Herb 1-1.5 ft. tall, glabrous, or sparsely hairy specially on the young parts. Stem woody at base, slightly winged above, once branched. Leaves 1-4 in. long, 0·2-0·9 in. broad, lanceolate, acute, tapering at base, subsessile, sparsely hairy ; veins ascending, about 16 pairs, slightly elevated beneath. Pedicel 0·05-0·1 in. Sepals 4, ovate, 0·2-0·25 in. long,

acuminate, 3-veined, hairy. Corolla 0·75 in. across ; petals obovate, emarginate, clawed, distinctly veined. Stamens 8. Ovary 0·3-0·4 in. long. Style short and thick. Fruit 1-1·5 in. long, 0·2 in. across at top, oblong, obcuneate, glabrous, broadest above, narrowed at base. Seeds ellipsoid, polished, mahogany brown.

Var B., **exaltata** Roxb. Leaves linear, with more numerous, short hairs on both surfaces.

Distribution. Wet places in moist low-country to 3000 ft.; common. Fl. Feby. Var. B, Bandarawela, Sept.

Ridley (3) does not mention the last two synonyms ; perhaps he did not see the Ceylon specimens of *J. erecta* L.

3. **J. villosa** Lam., Encycl., III, 331 ; C.P. 3297, 2794. A tall, woody, densely hairy shrub. Leaves 1·7-3·7 in. long, 0·35-1·1 in. broad, lanceolate, narrowed at both ends, shortly petiolate or sessile, hairy all over. Sepals 0·3 in. long, 0·15 in. wide at base, ovate, acute, hairy outside. Corolla 0·8 in. across ; petals oblong oblanceolate, retuse, 0·3 in. across. Ovary cylindric, hairy, 0·4-0·6 in. long. Fruit 1-1·25 in. long, 0·25-0·5 in. across, stoutly cylindric, base narrowed. Seeds dark red, ellipsoid, grooved.

Distribution. Near Galle ; Kandy. Fl. Sept., Oct.

4. **J. speciosa** Ridley, Journ. Bot., 1921, p. 259. Plant 3-4 ft. tall, densely softly tomentose-hairy all over. Leaves 2·5-3·5 in. long, 1 in. broad, lanceolate, narrowed at both ends ; petiole 0·25 in. long. Flowers 2 in. across, solitary, axillary. Pedicel 0·45 in. long, quadrangular, pubescent. Bractlets 2, lanceolate, acute, 0·4 in. long. Sepals 4, 0·55 in. long, 0·27 in. broad, triangular, acuminate, cuspidate, densely hairy on outer surface. Petals 0·8 in. long, 1 in. broad, obovate, retuse, distinctly 15-veined, shortly stalked. Stamens 8 ; filaments twisted in a counter-clockwise direction. Anthers extrorse. Stigma viscid, dome-shaped ; ovary 0·6 in. long, pyramidal. Capsule obconic, densely softly hairy. Seeds ellipsoid, not grooved, red.

Distribution. Haragama ; Maturata ; Peradeniya. Fl. Jan-June; bright yellow.

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(1) Ridley, H. N. The Indo-Malayan species of Jussiaea. Journ. Bot., LIX, 257 (1921).
(3) Ridley, H. N. Flora of the Malay Peninsula, I (1922), 827.
(2) Trimen, H. Handbook of the Flora of Ceylon, II (1894), 233.

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Ceylon Pink-spored Agarics.

BY

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The majority of Berkeley and Broome's species of *Rhodosporae* have not been recognised during the last eighteen years, and consequently re-description has not been possible. Notes on these, from the herbarium specimens and paintings, are included below. Measurements of the spores, and details regarding the presence or absence of cystidia in the herbarium specimens, have previously been published by Massee (Grevillea, XXI, pp. 77-82). Massee found that cystidia were wanting in most of the Ceylon species, and in general it has been possible to confirm his statement, as far as regards the herbarium specimens. But in this respect the herbarium species are apt to be misleading. In some cases, cystidia are well-preserved on the dried specimens, but in a recent examination of specimens collected during the last ten years I have failed, after repeated attempts, to find cystidia on some herbarium specimens on which cystidia were seen, measured, and described when fresh. Consequently it is not possible to decide that a species lacks cystidia, from failure to find them on a herbarium specimen.

VOLVARIA

Berkeley and Broome enumerated nine species of *Volvaria* in the Fungi of Ceylon. Coloured figures of two of these, *Volvaria terastia* B. & Br. and *Volvaria diplasia* B. & Br., were reproduced in Trans. Linn. Soc., XXVII, plates 33, 34, and there are paintings of four other species in Herb. Peradeniya. One species, *Volvaria Geaster* B. & Br. is a partly-expanded specimen of *Amanita vaginata*. One European species, *Volvaria volvacea* Bull., was recorded, and of the remainder two are generally large species, three are of medium size, and two are very small. Thwaites's collection numbers are somewhat confusing. *Volvaria diplasia* and *Volvaria terastia* were sent as 689 and 689 bis, while other collections were sent together in various combinations of the numbers 709, 777, and 790. Thwaites had apparently regarded the last three collections as the same species, and in Herb. Peradeniya the specimens of these three numbers are mounted on one sheet.

Volvaria terastia B. & Br. was re-described in Ann. Perad., IV, p. 40. The pileus attains a diameter of 20 cm., and is blackish brown, dark purple brown, grey, or brownish grey, densely clothed with radial adpressed silky fibrils. The stalk is white or grey, and up to 15 cm. high. The volva is usually large and stout, and black or blackish brown externally; internally it may be marked with distant yellow-brown patches. When the fungus expands, the surface of the volva usually splits into more or less rectangular areolae, separated by white bands. The spores are deep Indian red in mass, brownish by transmitted light, thick-walled, subglobose, 3·5-6 μ, or broadly oval, 5-6 × 4-5 μ, sometimes somewhat pyriform, with a prominent apiculus; the thick wall is penetrated nearly to the exterior by a narrow canal beneath the apiculus. Massee, Grevillea, XXI, pp. 77-82, gave the dimensions of the spores as 4 μ, or 4 × 3 μ. It grows on the ground.

In one example, the unopened volva had a shining, yellow-brown surface, which split into areolae bordered by sloping sides of grey hyphae.

Volvaria diplasia B. & Br. This species was re-described in Ann. Perad., IV, p. 51. It is usually smaller than *Volvaria terastia*. In the typical form the pileus is pale yellow or greyish white, up to 11 cm. diameter, densely clothed with fascicles of short silky hairs. The stalk is white, strongly attenuated upwards and more or less conical. The volva is thin, lax, usually sheathing the stem, tough, white or pale-brown and smooth externally, white with scattered yellow spots internally. The spores are deep Indian red in mass, but not markedly coloured when examined by transmitted light; they are oval, sometimes inequilateral, 7-10 × 4-5 μ. The edge of the gills bears oval cystidia, 50 × 28-30 μ, sometimes attenuated above and broadly flask-shaped.

This species grows on decaying stumps or wood, or on dead leaves matted together by mycelium. The form described by Berkeley and Broome is greyish white, but the colour is variable. In one example, partly hidden by a decaying log, the exposed half of the pileus was golden yellow and the shaded side pure white. Some specimens are blackish, and closely resemble *Volvaria terastia*, and the surface may split into radial anastomosing lines of blackish-brown silky fibrils.

Berkeley and Broome cited Thwaites 689 as *Volvaria diplasia* and 689 bis as *Volvaria terastia*. The spores of Thwaites 689 in Herb. Kew are oval, sometimes inequilateral, 7-10 × 4-5 μ, while those of the same Thwaites number in Herb. Peradeniya are 6-9 × 4-6μ. The Kew specimen shows cystidia on the gill edge. Thwaites 689 bis in Herb. Peradeniya is immature as to one specimen, while the other has

spores, globose, 3·5-6 μ, or broadly oval, 5-6 × 4-5 μ, identical with those described above for *Volvaria terastia*.

Volvaria volvacea Bull. This was recorded for Ceylon by Berkeley and Broome from Thwaites 790. The specimens in Herb. Kew have the pileus radially streaked with black lines, and in one the volva is feebly areolated. The spores are oval, 7-9 × 4-5 μ. There is a corresponding specimen, but small, on the sheet marked 777, 709, 790, in Herb. Peradeniya. These specimens are *Volvaria diplasia*.

Volvaria pseudovolvacea B. & Br. This was described by Berkeley and Broome from Thwaites 709, 777, 790, in part. They also described *Volvaria apalotricha* B. & Br. from Thwaites 709, *cum icone*, and *Volvaria coleata* B. & Br. from Thwaites 709,* *cum icone*. There are three figures in Herb. Peradeniya, one marked "709, a small form of 790", another, "709, 20 August. 1868," and a third, "Pileus delicately pilose, No. 709,* 15th August, 1868." The figures appear to be all the same species.

In Herb. Peradeniya, there is one sheet, marked 709, 777, 790, bearing specimens which vary from 3 mm. to 5 cm. in diameter. One specimen is *Volvaria diplasia*, as noted above. The larger specimens have spores 5 × 3 μ. The very small specimens have smaller spores, 3·5-5 × 3 μ.

In Herb. Kew, *sub Volvaria pseudovolvacea*, there are three sheets. One is marked by Thwaites "Nos. 709, 777, 790, Peradeniya, December. 1868-Jan. 1869, sent before, but I fear with other species admixed. This differs from those in having a volva and a pileus striato-ciliate;" the spores of these are oval, inequilateral, 4-6 × 3-4 μ, or globose, 3-4 μ. Another is marked "709 and 790, intermediate between the specimens sent you under these numbers, Peradeniya, Nov. 1868;" the spores of these are oval, 4-6 × 3-4 μ. The third sheet, No. 777, bears specimens with spores 7-10 × 4-5 μ, which are *Volvaria diplasia*.

For *Volvaria apalotricha* B. & Br., Berkeley and Broome cited Thwaites 709, *cum icone*. The specimen in Herb. Kew is marked by Thwaites, "709 (small form of No. 790), Peradeniya, Nov. 1868, see drawing." It has narrow gills, a small strict volva, and a pileus strongly radially black-fibrillose; its spores are 5-6 × 3·5-4 μ. Massee (*loc. cit.*) gave the dimensions of the spores, 3 × 2 μ.

Volvaria coleatus B. & Br. was Thwaites 709*, *cum icone*. The specimen is marked by Thwaites 709, without asterisk. The gills are narrow and the volva small; and the pileus is radially streaked with black fibrils, which tend to become free at the ends. The spores are 5 × 3 μ, not 3 × 2 μ as given by Massee.

All these three appear to be the same species. Berkeley and Broome stated that *Volvaria coleata* was closely allied to *Volvaria apalotricha* but differed in several important particulars. They did not, however, state what those particulars were.

Volvaria pseudovolvacea B. & Br. Pileus broadly convex, up to 5 cm. diameter, closely streaked with radial black-brown lines, white or greyish between ; flesh thin, white ; stalk up to 9 cm. high, 3 mm. diameter, white, slightly attenuated upwards, powdered, stuffed, almost solid ; gills narrow, equal, not crowded, margin entire ; volva usually small, thin, sheathing the stem, brownish white ; spores oval, inequilateral, 4-6 × 3-4 μ, or globose, 3-4 μ diameter. On the ground among dead leaves, or on wood.

The figures of *Volvaria apalotricha* and *Volvaria coleata* show specimens with pilei 2-3 cm. diameter, the total height of the fungus being 3·5-5 cms.

Volvaria microcoelia B. & Br. Berkeley and Broome separated this from Thwaites 709. There is no specimen in Herb. Peradeniya, and it has not been recognised again. The specimen in Herb. Kew has a pileus 12 mm. diameter, and a stalk 2·2 cm. high ; the stalk is thin and the volva small. It differs from the other species of *Volvaria* known from Ceylon in its spherical spores, 4-5 μ diameter.

According to Berkeley and Broome, the pileus is livid, clothed with scattered hairs, campanulate becoming plane, 1·2 cm. diameter ; stalk slender, 2·5 cm. high, 1 mm. diameter ; gills narrow, ventricose ; volva dark. As there was no painting of this species, the description of the colour must have been deduced from the dried specimen.

Volvaria glandiformis B. & Br. Pileus campanulate, then plane, 1·5 cm. diameter, centre umbonate, sulcato-striate up to the umbo, which is surrounded by a depressed ring, white, with a faint pink tinge, greyish in the centre, covered with long, silky, closely adpressed hairs ; stem 1·7 cm. high, 1·5 mm. diameter, equal, or expanding upwards, white, striate, solid ; gills pink, distant, thick, variously forked, equal, 1·5 mm. broad, rounded at each end ; volva somewhat bilobed, spreading, 4 mm. high, grey and silky externally; spores elliptic, 6-10 × 3·5-5μ. On the ground or on dead wood.

Berkeley and Broome described the pileus from the figure as ovate, estriate. The figure shows an unexpanded example, but the dried specimens are sections of two, one partly and one fully expanded, and in the latter the pileus is plicato-sulcate. The spores on the herbarium specimens are 5-8 × 3·5-4·5 μ ; those on recent examples, from which the

above description has been drawn up, were 8-10 × 4-5 μ. The recent specimens grew on the ground ; Thwaites's painting appears to show a specimen growing on wood.

PLUTEUS

Berkeley and Broome enumerated twenty-one species of *Pluteus* in the Fungi of Ceylon, all, as far as information is available, being collected at Peradeniya or in the close vicinity. In Thwaites's time, the Botanic Gardens were maintained in a "natural" condition, fallen trees being left to decay. Consequently, it is probable that, at that period, *Plutei*, and other agarics which grow on wood, were more abundant at Peradeniya than they are now. At the present day, *Plutei* are comparatively scarce, except for three species,—*Pluteus spilopus* B. & Br. which is frequent round decaying stumps ; *Pluteus glyphidatus* B. & Br., fairly common on decaying palm fronds in dense shade; and *Pluteus stigmatophorus*, which springs up occasionally round decaying stumps in flower pots at the Laboratory.

Pluteus spilopus B. & Br. Pileus up to 10 cm. diameter, almost plane, slightly obtusely umbonate, blackish brown, with darker radial streaks, minutely squarrose in the centre, elsewhere innately radially silky when dry, the cuticle becoming somewhat subgelatinous in very wet weather ; flesh white, moderately thick. Stalk up to 10·5 cm. high, usually attenuated upwards, up to 1·5 cm. diameter at the base, and 1 cm. at the apex, but more or less equal in dwarf specimens, solid, brittle, longitudinally striate, covered with black fibrils and minute black-brown particles in clusters. Gills free, ventricose, rounded behind, rather distant : cystidia on the edge of the gills, flask-shaped, up to 48 μ high, 26 μ diameter below, 8μ diameter above, or fusiform, up to 72 μ high, 26 μ diameter, or clavate, 40-50 × 16 μ. Spores globose, 5-7 μ, or broadly oval, 5-9 × 4-7 μ, smooth.

This species grows in numbers round decaying stumps, *i.e.* on the ground, not on the wood. It also occurs singly on lawns, probably from buried wood. Examples which appear during the rains are up to 11 cm. high, and the cuticle tends to become subgelatinous and to separate in flakes. Those which spring up in drier weather are only about half that height, and the surface of the pileus is dry and innately silky or fibrillose. Berkeley and Broome referred the wet weather form to *Pluteus cervinus*, while they described the drier weather form as *Pluteus spilopus*. It appears to be distinct from *Pluteus cervinus* in the squarrose centre of its pileus and the black points and fibrils on the stalk.

Pluteus spilopus is on record as a British species If, however, the British examples are correctly represented by Plate 325 of Cooke's Illustrations, there would not appear to be any doubt that they are not *Pluteus spilopus*. The two upper figures of the plate in question are marked M.J.B.,and they are apparently intended to be copies of Berkeley's figures of the Ceylon *Pluteus spilopus*. Thwaites sent paintings of the Ceylon agarics, and Berkeley had copies of these made which are now in the Library of the Kew Herbarium. Cooke appears to have copied the figures of *Pluteus spilopus* from Berkeley's copies, but they have been decidedly modified in the process.

The original painting evidently represents a distorted example. The pileus is bilobed, and the two halves are bent down on either side of the stalk, so that the painting of the whole fungus shows not only the upper surface of one half of the pileus, but also part of the lower surface of the other half. The furrow round the obtuse umbo, which was taken to be one of the distinguishing characters of the species, is no doubt attributable to the distortion of the pileus ; it does not occur in recent examples. There is no indication of any wood on the figures ; the specimens apparently grew on the ground. The colour of the pileus is very dark, the radial streaks being almost black. Cooke's reproduction omits the reverse view of the hinder half of the pileus, adds a piece of wood to the base of the stalk, and changes the colour completely.

Pluteus glyphidatus B. & Br. Pileus campanulate, obtuse, then expanded, umbonate, up to 5 cm. diameter, lemon yellow, covered with minute, ashy, or grey, close-set warts or points, or streaked with ashy fibrils, the centre remaining yellow, elsewhere becoming pinkish, margin striate; flesh thin, white. Stalk up to 6 cm. high, 4 mm. diameter, pale yellow or white, equal or slightly attenuated upwards, glabrous, powdered, tomentose at the base, solid. Gills yellowish, then pink, free, distant, broadly ventricose or equal, rounded at both ends, margin serrate ; cystidia on the gill edge in tufts up to 150 μ high, individual cystidia cylindric, flask-shaped, or broadly conoid, up to 150 μ high, 40 μ diameter, those on the face of the gills scattered, cylindric, slightly attenuated above, or broadly oval, 50 μ high, 30 μ diameter. Spores Indian red in mass, globose, 5-7 μ diameter, or broadly oval, 5-6 × 4 μ.

Common on decaying palm fronds on rubbish heaps in the shade, Peradeniya. The colour of the pileus varies, some examples being yellow with only a slight ashy covering, while in others the grey streaks almost entirely hide the yellow. The stalk is usually pale yellow, but some examples have a white stalk. A form occurs without any trace of yellow in the pileus or stalk.

Pluteus stigmatophorus B. & Br. Pileus up to 3·5 cm. diameter, broadly convex or almost plane, centre depressed, becoming repand and subinfundibuliform, black-brown in the centre, the cuticle elsewhere broken into minute black-brown scales or points arranged somewhat radially, pallid, then pinkish, between the scales. Stalk white or pallid, subtranslucent, up to 3·5 cm. high, 3 mm. diameter, equal or slightly expanded upwards, stuffed then hollow, glabrous above, with a few fibrils below which turn blackish when handled, or mealy with minute black granules, base slightly white tomentose, often swollen. Gills free, ventricose, rounded at both ends, white then pink ; cystidia on the edge of the gills in scattered groups forming more or less conical fascicles, ovate, up to 24 μ high, 16 μ diameter, or flask-shaped, 60 μ high, 20 μ diameter below, 6 μ diameter above, minutely verrucose, usually with an amorphous cap. Spores pink in mass, smooth, globose, 4-7 μ, or broadly oval, 5-7 × 4-5 μ. On dead wood, Peradeniya.

I know this species only from examples which develop on stumps of tea and rubber kept in pots under bell glasses at the laboratory. These are usually small. The type painting shows a larger specimen, 4 cms. high, 3·5 cm. diam., markedly repand. There is very little difference between the type paintings of *Pluteus stigmatophorus* and *Pluteus escharites*, and the former was re-described under the latter name in Ann. Perad., VI, p. 314. It differs from *Pluteus escharites*, as far as can be determined from the herbarium specimens, only in the shape of the cystidia.

The cystidia collapse and are difficult to detect on dried specimens. There is only one sheet, Thwaites 918, in Herb. Kew, and this bears halves of two specimens, and median longitudinal sections of three. The spores on the specimen examined by me were smooth, globose, 4-5 μ diameter.

Pluteus pulvinus B. & Br. Recent specimens which are considered to belong to this species have a pileus up to 4 cm. diameter, broadly campanulate, obtusely umbonate, pale greyish brown and minutely squarrose in the centre, elsewhere lightly radially streaked with greyish brown, innately radially silky, sulcato-striate at the margin. The flesh is very thin, practically absent except over the stalk. The gills are rather distant, ventricose, very broad (up to 7 mm.), free, but close to the stem, white, then salmon pink. The stalk is curved, white, longitudinally striate, glabrous, solid, up to 3·5 cm. high, 3 mm. diameter. The spores are globose, 5-6 μ diameter, or broadly oval, 5-6 × 4-5 μ. Indian red in mass when moist. It has scanty cystidia, flask-shaped, up to 50 μ high, 16 μ diameter. The specimens grew on the standing trunk of a dead jak tree.

Berkeley and Broome described *Pluteus pulvinus* as " Pileo convexo fortiter umbonato striato particulis pulveraceis consperso ; stipite subaequali solido ; lamellis latis ventricosis approximatis." They cited Thwaites 757***, *cum icone*. There is, however, no figure of this species in Herb. Kew or Herb. Peradeniya. Thwaites 757** and 757*** were sent together on the same sheet, and there is a figure of the first of these only, viz. *Pluteus conizatus*.

Pluteus balanatus B. & Br. This was described from a painting of an unexpanded specimen. The fully-expanded pileus is up to 3 cm. diameter, membranous, broadly convex, depressed in the centre, sulcato-striate on the outer half, diaphanous, pinkish when moist, becoming ashy or faintly yellowish in the centre on drying. The centre is usually smooth, but may be broken into small scales.

The gills are free, rather distant, very ventricose, up to 5 mm. broad, diaphanous then pinkish. The stalk is white, translucent, pruinose, up to 2 cm. high, 3 mm. diameter, slightly attenuated upwards. The spores are globose, 4-6 μ diameter, or oval, 8 × 6 μ. . The cystidia on the edge of the gills are ovoid, 40 μ high, 16 μ diameter, or flask-shaped, 40 μ high, 14 μ diameter below, 6 μ diameter above. On examination of the fresh specimens with a lense, the faces of the gills appear to bear cystidia, but these prove to be projecting hyphae, up to 100 μ long and 4 μ diameter. The recent specimens grew on wood.

A previous spore measurement on fresh specimens gave the dimensions, 7-8 × 5-6 μ, broadly oval, or 7 μ, globose.

Pluteus eugraptus B. & Br. Pileus up to 3 cm. diameter, plane, with a strongly developed, obtuse umbo, tawny, centre yellow brown, striate almost to the umbo ; flesh thin. Stalk up to 2 cm. high, 2-3 mm. diameter, expanding upwards, glabrous, yellow brown, white internally, stuffed, slightly tomentose with white tomentum at the base. Gills pink, ventricose, broad (4 mm.), rather distant, free. Spores pink, narrow oval, 7-9 × 4μ. On dead wood.

The type appears to be immature, and the spores found in it were oval, 4 × 3 μ. Berkeley and Broome gave the spores as subglobose or broadly elliptic, 6 μ long.

Pluteus flavo-marginatus Petch, Ann. Perad., VII, p. 282. Pileus about 2 cm. diameter, convex, sometimes slightly umbonate, orange red, sometimes with deeper crimson radial streaks, margin yellow. Gills white, then pink, broad, somewhat ventricose, free. Stalk up to 3·5 cm. high, 2 mm. diameter, yellow, glabrous, slightly tomentose at the

base. Spores pink, subglobose, 5-6 × 4-5 μ. Frequent at Hakgala on dead wood.

This species does not appear to have been collected by Thwaites, probably because the majority of his agarics were collected at Peradeniya, where this apparently does not occur.

Pluteus chrysaegis (B. & Br.) Petch; *Entoloma chrysaegis* B. & Br. Fungi of Ceylon, No. 182. Pileus 2·5-4 cm. diameter, broadly convex, golden yellow, fuscous in the centre, becoming brown when old, glabrous, margin striate, feebly sulcate when old, edge pale; flesh thin, white, becoming yellow. Stalk up to 3·5 cm. long, 2-3 mm. diameter, slightly attenuated upwards, white, becoming yellowish at the base, longitudinally striate, sometimes twisted, powdered below, glabrous above, solid. Gills free, crowded, rounded behind, up to 4 mm. broad, equal, white then pink. Spores salmon pink in mass, globose, smooth, 4-6μ diameter. On decaying stumps, Peradeniya.

The type painting shows the centre of the pileus depressed. *Pluteus conizatus* B. & Br., according to the figure of the latter, has an umbonate pileus and yellow stalk.

Pluteus escharites B. & Br. Judging from the type painting, this species closely resembles *Pluteus stigmatophorus*, and the descriptions of the two species do not reveal any marked differences. Berkeley and Broome cited Thwaites 868, *cum icone*, as the type. In Herb. Kew there are three collections under this number. On one sheet, the pilei are striate up to half way to the centre; on another they are feebly striate; and on the third strongly striate. The Ceylon label is attached to the second of these, which is nearest the type figure in general stature, though none of the specimens is the one from which the figure was drawn, that being Thwaites 868 in Herb. Peradeniya. The first of the three sheets is *Pluteus stigmatophorus*, while the specimens on the third have strongly angular spores and are an *Entoloma*.

Pluteus escharites has smooth spores, either globose, 4-5 μ or oval, 6×4 μ; and the microscopic structure of the cuticle is similar to that of *Pluteus stigmatophorus*. But it differs from the latter in having globose cystidia, 15-17 μ diameter, or obpyriform cystidia, 15 × 21 μ, scattered over the face of the gills and along their edges. It has not been collected recently. Massee stated that *Pluteus escharites* had no cystidia, and that the spores were elliptic-fusiform, very minutely warted, 10 × 6 μ. It is possible that he may have examined the *Entoloma* specimens.

Pluteus phlebophorus Ditm. The Ceylon specimens attributed to this species were sent by Gardner, accompanied by a painting. The

specimens are *Oudemansiella apalosarca* (B. & Br.), and the painting is a good representation of small examples of that species.

Pluteus aglaotheles B. & Br. This was Thwaites 1189, with a painting. Berkeley and Broome noted that it had urn-shaped cystidia, and there is a figure of the cystidia with the type in Herb. Kew. These cystidia are cylindric, slightly inflated below, with a rooting base, or flask-shaped with a rooting base, the total length being about 56 μ and the diameter up to 15 μ ; the apex is divided into three or four conical spines, about 10 μ long. The spores are oblong-oval, apiculate at one corner, 5-8 × 3-4 μ, or globose, 5 μ. The pileus in the type is somewhat spongy, as noted as Berkeley and Broome, but it has been hollowed out by insects. Thwaites 917 was described by Berkeley and Broome as *Pluteus subcervinus*. Massee stated that it possessed cystidia, more or less ventricose, with the apex crowned by a varying number of spicules, but he did not notice that these were exactly the cystidia figured by Berkeley and Broome for *Pluteus aglaotheles*. The spores of *Pluteus subcervinus* are identical with those of *Pluteus aglaotheles*. Unfortunately there was no painting of *Pluteus subcervinus*. It was said to have a livid brown pileus, but that was deduced from the dried specimen. On the evidence of the spores and cystidia, *Pluteus subcervinus* and *Pluteus aglaotheles* are the same. This species has not been collected again.

Pluteus albolineatus B. & Br. This was described from Thwaites 757, and a painting. The figure shows a specimen of the stature of *Pluteus glyphidatus*, blackish brown with white radial streaks, the latter being due to the splitting of the surface layers of the pileus. On the dried specimen the dark narrow bands of the surface layer anastomose. The spores are globose, 4-5 μ diameter, or oval, 6 × 5 μ ; cystidia have not been found. Thwaites 757 was considered by him a mixture. To his number 915, he added the note, "sent before under No. 757, which comprised more than one species, I believe," and to No. 925, "sent before intermixed with 757, Compare No. 760 and 795." No. 915 was named *Pluteus psichiophorus* B. & Br.; its pileus is radially streaked, but the dark streaks are broken ; its spores are globose, 4-5 μ, or oval, 6 × 5 μ ; cystidia have not been observed in the herbarium specimens. No. 925 was named *Pluteus aeolus* ; its spores are globose, 4-5 μ, or oval, 5-6 × 4-5 μ : cystidia have not been found in the herbarium specimens ; the surface of the pileus is broken into minute black warts, sometimes radially arranged. Thwaites 760 bis was referred by Berkeley and Broome to *Pluteus nanus* P.; its spores are globose, 4-6 μ, or oval, 5 × 4 μ, and the surface of the pileus is split into minute black warts. *Pluteus brunneopictus* B. & Br. was Thwaites 916 ; Thwaites stated that it

differed only from 915 in the marking of the pileus when seen by transmitted light. There are apparently two species in the type of *Pluteus brunneopictus*, one with spores 4-6 × 3, and the other with spores 6-9 × 5 μ : the pileus of the former is streaked or split radially, while that of the latter is broken up into minute warts.

Thwaites sent figures of two of the above species only, viz. *Pluteus albolineatus* and *Pluteus brunneopictus*. The latter figure would appear to have been drawn from a specimen with the smaller spores ; Berkeley and Broome gave the spores as ovate, and 6 μ long. *Pluteus albolineatus* and *Pluteus brunneopictus* would appear to be different, but it seems very doubtful whether *Pluteus psichiophorus*, *Pluteus aeolus*, and the Ceylon *Pluteus nanus* are distinct from *Pluteus albolineatus*. None of these has been recognised recently.

Pluteus grandineus B. & Br. The type contains parts of two examples. Berkeley and Broome stated that the pileus was covered with minute powdery warts, but this is true only of one specimen, and the warts are masses of spores. The spores are oval, 6-8 × 5 μ, or globose, 5 μ. It appears to be a species of the stature of *Pluteus pulvinus* B. & Br., but its spores differ from those of the latter. It has not been collected recently.

Pluteus marmoratus B. & Br. This, from the figure, is a stout species, the stature of *Pluteus spilopus*, but differs from *Pluteus spilopus* in colour, and in growing on wood. The marbling of the pileus is probably due to insect borings. There is no specimen in Herb. Peradeniya, and I have omitted to examine the Kew specimens. It has not been recognised recently.

Pluteus pelinus B. & Br. The spores of this species are broadly oval, 7-8 × 5-6 μ. or globose, 5-6 μ. Cystidia were not found in the type. This is a small species, growing on wood. It has not been collected recently.

Pleutus fusco-nigricans B. & Br. This species would appear to resemble *Pluteus pulvinus* B. & Br., in its general shape, striate pileus, and broad gills, but the figure shows a much darker pileus, and its spores are 5-6 × 4-5 μ. broadly oval.

Pluteus conizatus B. & Br. This was said to have the surface broken up into minute powdery patches, at length leaving the substratum exposed in parts. It was sent with the specimens named *Pluteus pulvinus*,

and Berkeley and Broome stated that in the latter the cuticle did not chip off as in *A. conizatus*. The figure shows a large species, exactly the size and stature of the wet weather form of *Pluteus spilopus*, and it would agree with the latter in that the cuticle chipped off. But the coloration of the pileus is not that of *Pluteus spilopus*, and it has a yellow stalk, while the spores are globose, 4-5 μ, or oval, 5 × 4 μ, with a well-marked apiculus. Cystidia were not found on the herbarium specimen. This species would appear to be distinct from both *Pluteus spilopus* and *Pluteus pulvinus*. It has not been collected recently.

Pluteus flavipes Petch, n. sp. Pileus 1 cm. diam., broadly convex, almost plane, pale yellow-brown, rugulose, margin striate. Stalk 1·5 cm. high, 1 mm. diameter, pale yellow, translucent, glabrous, slightly attenuated upwards, base slightly bulbous. Gills rather distant, broad, ventricose, erose behind, free, but close to the stem. Spores globose, 5-6 μ diameter. Cystidia not found. On dead wood, Peradeniya. October 15, 1914 ; specimen and painting, No. 4180 in Herb. Peradeniya.

ENTOLOMA

Entoloma purpureum Petch, n. sp. Pileus up to 8 cm. diameter, conico-campanulate, becoming broadly conico-campanulate, apex obtuse or slightly depressed, deep violet purple, almost black in the centre, densely covered with minute violet black scales ; margin striate; splitting when old ; flesh thin, bluish white. Stalk up to 8 cm. high, 6 mm. diameter, bluish violet, paler than the pileus, or pale blue, sparsely fibrillose, equal, or attenuated upwards, usually curved at the base, densely stuffed, then partly hollow, white, becoming bluish or greenish, internally. Gills broad (up to 1 cm.), attenuated outwards, rounded or truncate behind, with a decurrent tooth, rather distant. Spores brownish pink in mass, angularly ellipsoidal, 10-14 × 7-8 μ. On the ground among dead leaves.

Berkeley and Broome referred this species (Thwaites 799) to *Entoloma ardosiacum* Bull., var. *agauum* B. & Br., and to *Entoloma griseocyaneum* Fr., var. coloribus saturatioribus. The painting of the former shows a violet purple pileus and an indigo-blue stalk, while in the painting of the latter both the pileus and the stalk are indigo-blue.

Entoloma iodnephes B. & Br. The type painting of this species shows specimens with a violet pileus, and a pale violet or almost white stalk. Two specimens are conico-campanulate, more acute than *Entolo-*

ma purpureum, while the third is repand and cyathiform. It might be taken for a form of *Entoloma purpureum*, but it is apparently caespitose, and has smaller spores, angular ellipsoidal, 6-8 × 4-5 μ. The cyathiform specimen has a fistulose stalk which is probably abnormal. Berkeley and Broome gave the dimensions of the spores 7·5-10 × 5-7·5 μ ; Massee stated that they were angularly globose, 8-10 μ.

Entoloma retroflexum B. & Br. The type painting of this species shows a pileus 1 cm. diameter, and a flexuose stalk, 3·5 cm. high, 1 mm. diameter. In the type specimen the gills are very thick, and are rather closely encrusted with masses of calcium oxalate. Berkeley and Broome stated that the spores were angular, but it would seem probable that crystals of calcium oxalate were mistaken for spores. Massee stated that the spores were globose, with a slight indication of angular irregularities, 5 μ diameter, and added that it was "undoubtedly a species of *Hebeloma* ; the gills are pale ochraceous-tan, the spores are also tinged with the same colour and do not show a trace of red or pink." Few spores are to be found on the co-type in Herb. Peradeniya. After dissolving away the crystals, the spores seen were oval, inequilateral, smooth, 6-8 × 3-4 μ ; no colour was observable in them, and it is quite possible that they may be white in mass. This species has not been collected again.

Entoloma chrysaegis B. & Br. This has been re-described as *Pluteus chrysaegis* in Ann. Perad., V, p. 271.

Entoloma rhodopolium Fr. The Ceylon fungus assigned to this species by Berkeley and Broome has been re-described as *Entoloma infundibuliforme* in Ann. Perad., VI, p. 315.

Entoloma sericeum Bull. Thwaites 869, *cum icone*, was referred to this species by Berkeley and Broome as var. stipite fibrilloso-farcto. No specimens resembling the figure have been collected recently. The spores are oval, nodular, with a short, conical apiculus, 10-12 × 5-8 μ.

Entoloma mazophorum B. & Br. The spores of this species are angular, quadrate with a large conical apiculus, or sub-pentagonal, 9-10 × 6-7 μ. It has not been collected again.

Entoloma microcarpum B. & Br. This species was re-described in Ann. Perad., III, p. 255. Patouillard, Bull. Soc. Myc. France, XXIX, p. 210, refers it to *Mycena*.

Entoloma intermixtum B. & Br. The specimens named thus by Berkeley and Broome are larger specimens of *Entoloma microcarpum*.

Entoloma stylophorum B. & Br. This was re-described in Ann. Perad., VI, p. 315.

Entoloma pallido-gilvum B. & Br. There was no painting of this species, and Berkeley and Broome did not give the colour, except that the whole plant became umber in drying. The name, however, was probably derived from Thwaites's note on the specimen, "whole plant pale gilvous." The spores are more or less quadrate with a prominent conical apiculus, or pentagonal, 6-8 × 5 μ. Massee gave the spores as broadly pyriform, apiculate at the base, even, or sometimes very slightly angular, 6 × 5 μ. They are certainly angular. This species has not been recognised again. It would appear to be rather close to *Entoloma mazophorum*.

Entoloma argilophyllum B. & Br. There was no painting of this species, and the statements concerning its colour must have been based on the dried specimen. Berkeley and Broome stated that there might be some doubt as to the proper position of this species as they had not seen the spores. They described the gills as beset with little dark particles. The vertical section looks very much like that of a *Marasmius*, and the gills are distant, forked, and united by cross veins here and there.

Massee gave "spores elliptical, smooth, 8 × 5 μ, pale dingy ochraceous; cystidia cylindrical, 70-80 × 12-14 μ, abundant. The present species is a true *Hebeloma*; gills very ventricose, 2 lines broad in the middle, deeply sinuate, and almost free, dry and thin, pale dingy tan."

The cystidia are up to 80 μ long, 16 μ diameter above, contracted rather suddenly at about one third their height into a stem-like base, 5 μ, diameter, thick-walled, minutely verrucose. The dark particles noted by Berkeley and Broome are brown, and are shortly cylindrical, up to 10 μ long, 8 μ diameter, or irregularly ovoid. They readily break up into irregular fragments, and are the contents of cells which just reach the surface of the gill or project slightly above it. The same coloured masses occur in the stalks of the cystidia. Spores were not found on the type specimen. Massee would appear to have measured the brown masses. This species has not been recognised again.

Entoloma crassipes Petch, n. sp. Often caespitose; when young, convex, slightly umbonate, margin regular and incurved, becoming depressed or feebly umbonate, wavy, margin irregularly decurved, or

repand, up to 10 cm. diameter, white or cream-coloured, sometimes faintly ochraceous in the centre, smooth. Stalk stout, up to 11 cm. high, 3 cm. diameter, equal, or fusiform, or expanding upwards, white, at first fibrillose, the outer layers frequently splitting so that the stalk is lacunose, solid, white and spongy internally, base white tomentose. Gills rather distant, narrow, attenuated outwards, sinuato-decurrent, edge often irregular, white, becoming pale pink. Spores pale pink in mass when dry, but with a brown tinge when wet, very pale brown by transmitted light, oval, coarsely warted, 5-7 × 3-4 μ.

This is a common species among dead leaves or on rubbish heaps at Peradeniya, but I have not been able to trace it among the specimens described by Berkeley and Broome.

Entoloma brunneum Petch, n. sp. Pileus up to 3 cm. diameter, convex, or conico-convex, with a prominent rounded umbo, pale brown or bay brown, clothed with minute squarrose scales, especially in the centre, and minutely radially silky ; margin uneven, striate when old ; flesh thin. Stalk 6-7 cm. long, 3-5 mm. diameter, slightly attenuated upwards, of the same colour as the pileus, with a few dark fibrils, longitudinally striate, twisted, base white and tomentose, internally white, stuffed then hollow. Gills distant, broad, ventricose, in three series, the longer sinuato-adnate, white, then pallid, finally pink. Spores Indian red in mass when moist, pale red when dry, angular, generally quadrilateral in plan, 8-12 μ broad, guttulate. Cystidia not found. On the ground among grass, Peradeniya, Nov. 14, 1911 ; No. 3272 in Herb. Peradeniya.

The shape of the pileus is that of *Entoloma mazophorum*, but the colour is different, the stalk longer, and the spores larger and different in shape.

LEPTONIA

Leptonia gnaphalodes B. & Br. Pileus 2 cm. diameter, almost plane, centre umbilicate, greyish brown, with paler radial streaks, minutely scaly, especially in the centre. Stalk 2·5 cm. high, 1·2 mm. diameter, expanding at the apex, greyish pallid, pellucid, feebly longitudinally fibrillose, base white tomentose. Gills moderately distant, ventricose, adnate with a decurrent line. Spores pink in mass, angular with a short conical apiculus, 8-12 × 6-8 μ. Cystidia not found. On the ground.

Leptonia gnophodes B. & Br. Pileus up to 3 cm. diameter, deeply infundibuliform with a plane or decurved margin, or convex, or conico-

convex, sometimes truncate above, when moist deep brown, glabrous, strongly striate, becoming grey with the surface split into small, innate, dark grey scales when dry. Stalk up to 6 cm. high, 3mm. diameter, greyish brown, pellucid, glabrous, pruinose at the apex, equal, or expanding upwards, often flattened at the apex, curved and white tomentose at the base, hollow, brown internally. Gills broadly ventricose, or with the lower edge even, pinkish brown with a pale edge, adnate, or adnate with a decurrent tooth, or decurrent. Spores angularly globose, 8-12 μ diameter, or oval, 8-10 × 6-8 μ. Cystidia flask-shaped, inflated at the apex, or nine-pin shaped, up to 64 μ high, 12-24 μ diameter below. On the ground among grass, sometimes in a ring.

This species occurred in my garden at Peradeniya, and the various shapes described are from specimens from the same patch. Normally it is infundibuliform, but some specimens are convex or conico-convex. In some forms it is rather *Eccilia*.

Berkeley and Broome described this species from Thwaites 841 *cum icone*, and stated that it was mixed with *Leptonia serratulus*. There were three paintings, which they named *Leptonia gnophodes*, *Leptonia serratulus*, and *Leptonia serratulus* var. with a solid stem. The last named is undoubtedly the same as *Leptonia gnophodes*. The figure assigned to *Leptonia serratulus* is bluish grey. This coloration does occur in some stages of drying in *Leptonia gnophodes*, and the figure could not be separated from the others on that character. But it also shows dark blue points on the gill edge, a feature which I have not observed in *Leptonia gnophodes*.

NOLANEA

Nolanea apiculata Petch, n. sp. Pileus up to 2 cm. diameter, broadly campanulate or almost plane, with an acute umbo sometimes produced into a cylindrical tip about 1 mm. high, sometimes depressed round the umbo, blackish brown, paler at the margin, radially silky, striate when moist, thin, almost membranous. Stalk up to 4 cm. high, 2 mm. diameter, pale brown, slightly attenuated upwards, glabrous, or with a few longitudinal fibrils, strigose at the base, cartilaginous. Gills brown then pink, moderately crowded, ventricose, rounded or attenuated behind, free but close to the stem. Spores pink, nodular, angularly oval with a long conical apiculus, 8-12 × 5-7 μ. On the ground, Peradeniya, October 18th, 1914; specimens and painting, No. 4189 in Herb. Peradeniya.

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Agaricaceae Pleuropodes Zeylanicae

BY

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The following list includes descriptions of the species of *Pleurotus*, *Claudopus*, and *Crepidotus* recorded for Ceylon by Berkeley and Broome, and of other species of the same genera recently collected.

PLEUROTUS

Pleurotus reticulatus Petch, Ann. Perad., VI, p. 198. Stalked; pileus 6-12 cm. diameter, infundibuliform, outer half at first decurved, then almost wholly infundibuliform, yellow brown in the centre, yellow or brownish yellow elsewhere, blackening in the centre and becoming paler at the margin when old, glabrous, margin not striate; total height 6-9 cm.; flesh white over the gills, becoming yellow over the stalk. Stalk 3-3·5 cm., high, 1-1·4 cm. thick, equal, expanding into the pileus, expanding slightly at the base, golden yellow, reticulated with red brown lines of innate fibrils, solid, slightly tomentose at the base, excentric, internally golden yellow or golden brown. Gills yellow, becoming pallid when old and turning green on drying, decurrent, continued down the stem in lines of four lengths which frequently anastomose, crowded, broad, arcuate, edge slightly irregular. Spores white, globose or broadly oval, 4·5-6 μ diameter. On dead wood, Hakgala, April 1912, September 1914; type, No. 3536 in Herb. Peradeniya; painting, No. 4132.

Pleurotus dryinus P. This species was recorded for Ceylon by Berkeley (Hooker's London Jour. Bot., VI, pp 479-514) among the fungi sent by Gardner, No. 88. There is no specimen in Herb. Kew, and the paintings No. 88, sent by Gardner, are marked "Hantane (no specimen)". The figures show a deeply infundibuliform species which has narrow, crowded gills and a central stalk, with a collar on the stalk. They are quite a good representation of *Lentinus Sajor-Caju*. The name *Pleurotus dryinus* should therefore be deleted from the Ceylon list.

Pleurotus angustatus B. & Br., Fungi of Ceylon, No. 141. Caespitose or scattered; pileus violet grey, sometimes amethyst, at first,

paler towards the base, becoming pale livid brown when old and sodden, orbicular, sometimes circular, or spathulate, sometimes obliquely infundibuliform, glabrous, upper layer subtranslucent, up to 8 cm. diameter, or 10 × 5 cm., margin at first inrolled. Flesh white, thin except over the stalk. Stalk stout, excentric, sometimes almost lateral, but in the latter case margined above by a continuation of the pileus without gills, up to 4 cm. high, 1·3 cm. diameter, white, even or ridged or reticulated, glabrous or nearly so. Gills dead white, rather crowded, decurrent or occasionally sinuato-decurrent, narrow. Spores white, oblong-oval, slightly inequilateral, 8-12 × 4-5 μ.

Pleurotus flabellatus B. & Br., Fungi of Ceylon, No. 145; *Pleurotus scytocephalus* B. & Br., Fungi of Ceylon, No. 146; *Pleurotus leptogramme* B. & Br., Fungi of Ceylon, No. 147. Caespitose or scattered, often arising in tufts from an extended basal stroma; white, or white with a pinkish tinge, or in dry weather, mouse grey above with salmon pink gills; flabelliform, orbicular, or reniform, with a short stem-like base, sometimes shortly stalked, glabrous when moist, innately radially silky in dry weather, or becoming tomentose towards the base, margin entire or lobed, up to 11 × 7 cm. Gills white, rather crowded, decurrent usually to the base of the pseudostalk, sometimes anastomosing below; base of pseudostalk, or stalk if present, tomentose or strigose. Spores white, oblong-oval, inequilateral, apiculus excentric, 6-10 × 3-4 μ.

There are two forms of this species, which are distinct in habit, but do not appear to be distinguishable by any definite morphological characters. One of these grows on fallen branches, or decaying palm stems, or stems of soft wood trees, *e.g.*, dadap; in this form the fungus is usually white, rarely pinkish behind, thin, tender, often lobed and undulating, glabrous when moist, with a matt surface when dry, and occurs singly, or in tufts of two or three connate at the base, but without a definite basal cushion. The second form occurs on wounds caused by fire injury, etc., on living trees, *e.g.*, *Hevea*, and arises in large clusters from stout basal cushions which often originate from cracks or beetle-holes and extend for some distance over the surface of the wood. This second form is stouter, and examples which appear in the drier weather towards the close of the rains are mouse grey with a slight pinkish tinge above, and salmon pink below. The pink colour soon fades.

The pileus in wet weather appears glabrous, but in drier weather innately radially silky. As the pilei age, a slight tomentose growth extends from the base towards the margin. Specimens which appear radially silky when fresh have a matted, finely tomentose surface when dry, except near the margin.

From the descriptions and specimens, *Pleurotus flabellatus* is the thin, tender form, while *Pleurotus leptogramme* is the stouter form with a well-developed basal cushion. The latter was apparently described from specimens on which the thin tomentose covering was well developed, but glabrous specimens occur in the type collection. The fine lines towards the margin, noted by Berkeley and Broome for *Pleurotus leptogramme*, appear only on drying; they may extend radially to the margin almost from the base and depend upon the condition of the fungus when gathered.

Pleurotus scytocephalus was said to differ from *Pleurotus flabellatus* in having smaller spores, 6 μ long. This measurement is within the limits of the dimensions of the spores of the latter. The type of *Pleurotus scytocephalus* in Herb. Kew contains two small specimens, which appear to be merely immature examples of *Pleurotus flabellatus*.

Pleurotus versiformis Berk., Hooker's London Jour. Bot., VI, p. 479. Berkeley's description is as follows.—Hygrophanous, white; pileus membranaceous, umbilicate, infundibuliform, flabelliform, spathulate, or sub-linear; stalk short, glabrous or sprinkled with a few strigose fascicles, sulcate, cartilaginous when dry; gills rather broad, attenuated behind, decurrent, interstices rugulose. Like *Pleurotus petaloides*, but not closely allied; might rather be referred to *P. mutilus*.

Gardner's specimen is in Herb. Kew. It was apparently gathered in bad condition and is scarcely recognisable. It might be *P. flabellatus*, but the description does not fit that species.

Pleurotus polychromus B. & Br., Fungi of Ceylon, No. 143. Orbicular, convex, strongly elevated and sub-umbonate behind, up to 3·5 cm. broad and 3 cm. long, deep purple-brown, becoming red-brown towards the margin, extreme margin pale or white; when old entirely red brown; glabrous when moist, very minutely silky when dry; margin inrolled at first; flesh thick, white. Stalk excentric, almost lateral, short, stout, up to 4 mm. high, 4 mm. diameter, minutely tomentose. Gills white, becoming spotted red where bruised, blackening in drying, rather crowded, narrow, no cystidia. Spores white, narrow-oval, inequilateral, 4-6 × 2-3 μ.

Pleurotus rigescens B. & Br., Fungi of Ceylon, No. 142. This species was described by Berkeley and Broome from Thwaites 695, *cum icone*, numbers 97 and 88 in part being also cited. Thwaites 695 is undoubtedly *Pleurotus polychromus*, and the figure is that species; the colour of the pileus is red brown. The figure from which Berkeley and Broome described *Pleurotus polychromus*, Thwaites 960, is the

younger stage, the pileus being purple-brown. In Herb. Peradeniya, Thwaites 88 and 695 are mounted on one sheet ; the specimens include *Pleurotus polychromus*, *Pleurotus testudo*, and a *Marasmius*. In Herb. Kew, *sub Pleurotus rigescens*, are Thwaites 695, 87, 88, and 97. No. 695 is *Pleurotus polychromus* ; No. 87 is *Crepidotus phaeophyllus* Berk.; No. 88 is a *Marasmius*. I regret that I have mislaid my notes on No. 97, and that number is apparently not represented in Herb. Peradeniya. Berkeley and Broome's description, however, is drawn up chiefly from Thwaites 695, which is *Pleurotus polychromus*, but in view of the confusion of specimens under *Pleurotus rigescens*, it would seem preferable to retain the former name.

Pleurotus galeaeformis B. & Br., Fungi of Ceylon, No. 144. Berkeley and Broome's description of this species is as follows,- Pileus 1·8 cm. across and as much high, oblique, helmet-shaped, thin, striate, pale in front, rufous behind ; stalk cylindric, 2 lines high, not a line thick, polished, arising from a fuscous, orbicular base ; gills broad, pale ochraceous, interstices veined. Thwaites No. 1207, *cum icone*, was cited. There is no figure, No. 1207, in Herb. Peradeniya, nor among the copies in Herb. Kew. The type in Herb. Kew contains a specimen and a half, resembling in shape *Favolaschia bispora*, but stalked.

Pleurotus pseudobarbatus Petch, n. sp. Sessile, orbicular or flabelliform, up to 2 × 1·5 cm., pale ochraceous, becoming dark-brown when old, covered behind with white spongy tomentum, which becomes fasciculate in front, margin glabrous; tomentose round the base ; gills pallid, becoming pale brown to grey brown, the longer broad and ventricose, the shorter lower, so that the gills appear more or less distant, margin lacerate ; spores white, broadly oval or subglobose, 4 × 3 μ. On a dead branch, Peradeniya, June 25, 1919 ; specimen and painting, No. 6016 in Herb. Peradeniya.

The white tomentum forms a spongy layer, with a smooth outer coat, but in front is broken up into scattered erect fascicles ; it is composed of hyphae 2 μ diameter, usually thin-walled. The gills are rather thick, and their context contains irregularly distorted, thick-walled or almost solid hyphae, 3-4 μ diameter.

Pleurotus testudo Berk. Pileus semi-elliptical or orbicular, regular, up to 2·5 cm. broad, sometimes irregularly lobed and up to 5 × 2·5 cm., sessile, convex, more or less umbonate at the point of attachment, grey or brownish grey, paler towards the margin, becoming brown when old and sodden, sometimes white, tomentose behind with minute, erect,

scattered fascicles of white hairs, margin faintly radially striate. Flesh subgelatinous, but the pileus not viscid. Gills rather distant, narrow, white, becoming brown when old, bearing numerous prominent cystidia. Cystidia fusoid, 50-70 μ long, 12-14 μ diameter, the free part conical or flask-shaped, thick-walled below, solid or with a narrow central cavity above, yellow in dried specimens. Spores white, oblong, ends rounded, 5-7 × 2·5 μ.

This species is not uncommon at Peradeniya. It was sent to Berkeley by Gardner, and was described in Hooker's London Journal of Botany, VI, p. 484. In the Fungi of Ceylon, Berkeley and Broome stated that it is *Agaricus barbatus* B. & C. in part, and refer to Cuba, No. 44. But it was described before any Berkeley and Curtis specimens, and so cannot be any of their species in part. Moreover, Wright's specimen No. 44 in Cuban Fungi is *Pleurotus barbatulus* B. & C., described in 1859.

In Saccardo, Sylloge, XI, p. 62, it is stated, on the authority of Cooke, that *Pleurotus testudo* is a *Crepidotus*. That is incorrect.

Pleurotus sub-barbatus B. & C., Journ. Linn. Soc., X, p. 288. Sessile ; flabelliform, orbicular, or elongated, up to 1 cm. diameter, slate coloured to blackish brown, densely strigose with coarse, greyish, adpressed fascicles from the base over two-thirds or three-quarters of the pileus, feebly silky, appearing glabrous, over the marginal zone ; margin radially striate when moist. Gills brownish black, crowded, narrow : no cystidia. Spores white, oval or oblong-oval, 5-6 × 3·5-4 μ. The strigae extend over the wood round the base of the fungus ; they consist of thick-walled, hyaline hyphae, 2-3 μ diameter, sometimes united into long, brown, tapering fascicles, 30 μ diameter.

Pleurotus semisupinus B. & Br., Fungi of Ceylon, No. 151. Sessile : at first globose, with a minute central orifice, then expanded, circular, saucer-shaped, up to 3 mm. diameter, with a white, tomentose, central papilla, about 0·3 mm. diameter; white, hymenium becoming tan coloured; externally densely radially strigose. Gills distant, subventricose, attenuated behind, arising near the central papilla, covered with crystals of calcium oxalate ; cystidia fusoid, with a long point, 24-26 × 8-12 μ, or obconoid or irregularly triangular, up to 30 μ high, including a curved horn, 6-12 μ long, at each corner. Spores oval, inequilateral, 4-6×2-2. 5 μ. Hairs on exterior hyaline, flexuous, thick-walled, 2-3 μ diameter.

Pleurotus gelatinosus Petch, n. sp. Pileus up to 1 cm. diameter, sessile, usually circular and centrally attached, sometimes orbicular

and attached laterally, subgelatinous, pale slaty grey, becoming dark slate, and finally blackish brown or black, pruinose round the point of attachment, the pruina appearing rusty on dried specimens ; margin even when young, becoming crenate when old ; black internally. Gills moderately crowded, rather broad, at first grey, then dark slate, finally blackish-brown with a pale grey edge ; no cystidia. Spores white, globose, 4-5 μ diameter.

This species was Thwaites 391, and was included by Berkeley and Broome under *Pleurotus subbarbatus* B. & C. as " a tender variety which comes very close to *A. striatulus*. This at length collapses and clings close to the matrix. " The " collapsed " position, flat on the wood, is the natural habit.

SCHIZOPHYLLUM

Schizophyllum commune Fr. Berkeley and Broome enumerated two species of *Schizophyllum* from Ceylon, viz. *Schizophyllum commune* Fr. and *Schizophyllum multifidum* Fr. Bresadola, in Ann. Myc., IX, p. 549, refers to the second as " *Schizophyllum commune* var. *multifidum* (Batsch) Fr. in Berk. Fung. Ceylon, No. 430. " These are merely forms of the same species. It is not possible to maintain the second distinct, even as a variety. The spores of *Schizophyllum* are white or pale yellow in mass, hyaline by transmitted light, oblong-oval or cylindric, with the apiculus at one corner ; measurements at Hakgala (5600 ft.) gave the dimensions, 4-6 × 2 μ, at Peradeniya (1600 ft.) 5-7 × 2·5-3 μ.

CLAUDOPUS

Claudopus fusco-lamellatus Petch, Ann. Perad., VI. p. 200. Sessile; orbicular or flabelliform, up to 7 × 5 cm., cream coloured, smooth behind, sometimes slightly tomentose towards the margin ; margin incurved ; gills slightly fuscous, blackening in drying, narrow, crowded ; spores salmon pink in mass, oval, inequilateral, 4-5 × 2-3 μ. On a decaying tree trunk, Hakgala, April 1914 ; No. 4061 in Herb. Peradeniya.

Claudopus repens Petch, Ann. Perad., VII, p. 282. Resupinate, sessile, orbicular, up to 4 mm. diameter ; margin white, tomentose ; hymenium pinkish red ; gills few, distant ; spores irregularly globose, nodular, with a stout conical apiculus, 6-8 × 4-6 μ. On the under side of rotting logs, arising from white cords of mycelium which spread out here and there into cobwebby sheets. Hakgala, December 1917 ; No. 5621 in Herb. Peradeniya.

CREPIDOTUS

A. Spores smooth

Crepidotus flavomarginatus B. & Br., Fungi of Ceylon, No. 238. Shortly stalked ; pileus at first galeate, becoming convex or almost plane, orbicular, 1-1·6 cm. broad, pale yellow, pale ochraceous, or orange, clothed with adpressed flocci, sometimes glabrous, sometimes united behind to the substratum by a tuft of white hyphae when old ; stalk excentric, stout, up to 2 mm. long, 1 mm. diameter, of the same colour as the pileus, becoming brown, floccose, generally arising from a tuft of white or yellowish hyphae ; gills broad, ventricose, adnate or sinuato-adnate, yellow, becoming brown, margin yellow and serrate; spores yellow brown, smooth, broadly oval, 7-9 × 5-7 μ, or globose, 6-8 μ : edge of gills furnished with short clavate hairs, up to 20 μ high, 1·5 μ diameter at the base, 5 μ diameter at the apex, apex rounded. General at Peradeniya.

A specimen from Hakgala (No. 6146) has dark yellow-brown spores.

Crepidotus phaeophyllus Berk., Decades of Fungi, No. 152. Shortly stalked ; pileus flabelliform, simple, about 2 × 1 cm., or deeply lobed, up to 4 × 2 cm., convex, then almost plane, white or pallid when moist, tan coloured when dry, glabrous; stalk excentric, almost lateral, short, white, usually arising from a tomentose patch ; gills crowded, very narrow, attenuated outwards, the longer adnate, pallid, then purple grey or purple, dark purple brown to black when dry ; spores distinctly purple in mass when moist, pale purple by transmitted light when fresh, yellow brown in herbarium specimens, oval, smooth, 6 × 4 μ. Peradeniya ; not common.

Both this and the following species are remarkable for the purple coloration of the spores under certain conditions.

Crepidotus melleus (B. & Br.) Petch ; *Aschersonia mellea* B. & Br., Fungi of Ceylon, No. 798. Sessile or shortly stalked : pileus regular, semi-elliptic, convex, or orbicular, reniform, or flabelliform, repand and undulating, up to 7 × 5 cm., white, ochraceous behind, becoming tan coloured when dry, glabrous, with slight white tomentum at the base, sometimes viscid when moist ; margin at first inrolled, appearing striate when moist ; flesh thick, white ; stalk short, up to 3 mm. long, white, longitudinally fibrillose, expanding upwards, excentric ; gills moderately crowded, broad, sometimes ventricose, decurrent or adnate, pallid, becoming purplish grey, or brown from the spores ; spores in mass dark purple brown when moist, tawny olive (Ridgway) when dry, pale purple or yellow brown by transmitted light, smooth, oval, slightly in-

equilateral, thick-walled, 6-10 × 4-8 μ ; edge of gills fringed with cylindric or slightly clavate hairs, 6 μ long, 3 μ diameter. Common on decaying tree trunks, especially mango, at Peradeniya.

This is the commonest *Crepidotus* at Peradeniya, but it was not described by Berkeley and Broome. There are specimens of it, however, included in Thwaites 954 in Herb. Peradeniya.

Aschersonia mellea B. & Br. consists of small specimens of the same species.

In dry weather, the pileus may be semi-elliptic, convex, with an incurved margin, and the gills pallid, becoming purple grey. The spore print from such specimens is purple brown, and the spores by transmitted light pale purple. But when dried for the herbarium the spores are yellow-brown.

In wet weather, the pileus is repand, and flabelliform or orbicular. The gills are white or pallid, becoming brown when covered with spores. The masses of spores on the pilei, and the spore print when moist, are dark purple brown, the latter becoming tawny olive when dried on white paper. By transmitted light, the spores are yellow brown, with sometimes a faint purple tinge in the thick wall.

Crepidotus grumosopilosus B. & Br., Fungi of Ceylon, No. 239. Very shortly stalked or sessile, orbicular, up to 3 × 2·5 cm., convex, densely covered when young with coarse suberect fascicles of tawny strigae, becoming white when expanded, with scattered radial fascicles of tawny fibrils behind, silky with a few red brown points in front : stalk very short, excentric; gills ventricose, very broad, rather distant, white then brown ; spores pale yellow brown, smooth, broadly oval or subglobose, 7-10 × 5-6 μ. On dead branches, Peradeniya.

The strigose fascicles on the pileus are composed of parallel hyphae united laterally ; these hyphae are 8 μ diameter, sometimes inflated to 10 μ, constricted or not at the septa, with close-set, regular, internal annular thickenings.

Berkeley and Broome cite Thwaites 954a, *cum icone*. Thwaites 954 was a mixture, including *Crepidotus epicrocinus* B. & Br., *Crepidotus grumosopilosus* B. & Br., a species said to be a variety of *Crepidotus epicrocinus*, and another species which does not appear to have been named. It is very doubtful whether the figure is that of the specimens described by Berkeley and Broome as *Crepidotus grumosopilosus* ; it would appear to be more probably *Crepidotus truncatus*.

Crepidotus pezizula B. & Br., Fungi of Ceylon, No. 343. Sessile; usually centrally attached, at first globose, becoming pezizoid, up to 2

mm. diameter, exteriorly ashy, with a pinkish tinge, minutely tomentose, hyphae of the tomentum hyaline, minutely spinulose ; gills pale brown with a white edge, rather distant ; edge of gill bearing hairs up to 20 μ high, 2μ diameter below, hyaline, clavate, expanding to 3 μ above, or suddenly inflated into a globose head 6 μ diameter ; spores yellow brown, smooth, broadly oval, 6-9 × 4-6 μ.

This species is parallel to *Pleurotus semisupinus* B. & Br.

B. Spores warted or spinulose

Crepidotus hepatizon Berk., Decades of Fungi No. 151. Fasciculate, stalked ; pileus horizontal, at right angles to the stalk, orbicular, flabelliform, or reniform, up to 6 × 4 cm., convex, then plane or undulating, frequently proliferous at the margin when old, bay brown behind, greyish brown towards the margin, becoming ferruginous, minutely hoary ; stalk vertical, excentric, almost lateral, up to 2·5 cm. high, 5 mm. diameter, cartilaginous, compressed and lacunose, solid, glabrous, tomentose at the base, pale purplish brown ; gills ferruginous, crowded, ventricose, sinuato-decurrent ; spores yellow brown, spinulose, oval or subpyriform, 4-5 × 3 μ, or globose, 3-4 μ diameter. Apparently rare ; on rotten wood, Alagalla, July 1917 ; specimen and painting, No. 5238 in Herb. Peradeniya.

The habit of this species, with an erect stout stalk and the pileus at right angles to the stalk, is quite different from that of the other Ceylon species of *Crepidotus*.

Crepidotus velutinus Petch, n. sp. Stalked ; pileus orbicular, convex, up to 2 × 1 cm., deep yellow brown or chocolate coloured, minutely areolated, velvety, clothed with minute, erect, yellow brown, flask-shaped or conical hairs, up to 30 μ high ; stalk almost lateral, stout, 2·5 mm. diameter, fuscous, minutely velvety, with a ring of white tomentum at the base ; gills pallid, then pale brown, somewhat distant, slightly ventricose, decurrent ; spores dark brown in mass, yellow brown by transmitted light, spherical, 6-10 μ diameter, coarsely warted with large scattered warts. On a dead twig, Peradeniya ; specimen and painting, No. 4316 in Herb. Peradeniya.

Crepidotus citrinus Petch, n. sp. Shortly stalked ; pileus at first galeate, margin inrolled, then almost plane, orbicular, up to 2 × 1 cm., pale yellow or lemon yellow, pruinose, sometimes white behind, lying flat on the substratum and ultimately attached by white hyphae ; margin plicato-crenate, sometimes lobed ; stalk very short, excentric, curved, yellow, minutely tomentose ; gills rather distant, broad, edge pale and

serrate, yellow, then brownish yellow ; spores yellow-brown, spherical, 5-8 μ diameter, or oval, 8-10 × 6-8 μ, covered with large blunt spines. On dead trunks, Peradeniya ; type No. 3547 in Herb. Peradeniya. There is an unnamed specimen of this, Thwaites 956, in Herb. Peradeniya.

Crepidotus reversus B. & Br., Fungi of Ceylon, No. 343. Sessile or shortly stalked ; pileus deep pink or red, becoming brownish red towards the margin, orbicular, convex, up to 7 × 5 mm., scurfy, with a patch of white tomentum behind and extending over the substratum, margin at first incurved; gills at first deep pink, then red brown, rather distant ; cystidia on the edge of the gills oblong, sometimes inflated in the middle, up to 24 × 12 μ ; spores pale ferruginous in mass, pale yellow brown by transmitted light, coarsely warted, globose, 5-7 μ diameter, or broadly oval, 6-8 × 4-6 μ. On dead branches, Peradeniya.

In dried specimens, the pileus bears minute, scattered, deep crimson granules visible under a magnification of 40 diameters. The gills bear similar but smaller granules, visible when mounted.

Berkeley and Broome's type specimen contains only very minute examples, about 1 mm. diameter.

Crepidotus epicrocinus B. & Br., Fungi of Ceylon, No. 237. Sessile, attached almost laterally by white strigae ; pileus suborbicular or reniform, up to 2·5 cm. broad, convex, pale yellow, with red, more or less radiating streaks, minutely tomentose with loose, irregularly intertwined hyphae ; hyphae of the tomentum thick-walled, irregularly contorted, rather closely septate ; gills pale yellow, becoming ferruginous ; spores yellow brown, warted, with scattered warts, spherical, 4·5-7 μ, or subglobose, 6×5 μ.

This species has not been collected again. Berkeley and Broome stated that the pileus was bright orange-chrome-yellow. The colours given above are those of the type figure.

Crepidotus truncatus Petch, n. sp. Sessile, dorsally attached ; pileus elliptical, lobed behind, broadly convex, 4 × 2·5 cm., pallid, covered with a thin layer of matted fibrils, strongly tomentose and white at the point of attachment, striate from the margin over half the pileus when moist ; gills not crowded, very broad (up to 1 cm.), ventricose, pallid then brownish, truncate behind, terminating at an excentric, white, tomentose area under the point of attachment ; spores ochraceo-ferruginous in mass, pale yellow brown by transmitted light, globose, minutely warted (appearing smooth under a magnification of 360 diameters), 5-7 μ. On a dead branch, Peradeniya ; No. 4384 in Herb. Peradeniya.

The specimens referred to by Berkeley and Broome as a variety of *epicrocinus* with a dull ferruginous pileus and broader gills has similar minutely warted spores which appear smooth under a magnification of 400 diameters, but they are larger, either spherical, 7-9 μ, or oval, 8-10 × 6-8 μ. The pileus in these specimens is sessile, dorsally attached, minutely adpressed tomentose, and the gills are broad.

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Cassia Leschenaultiana DC.

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

In his "Enumeratio Plantarum Zeylaniae" Thwaites included *Cassia Wallichiana* DC., with the description "Caule erecto, rigido, parce ramoso; foliolis 20-25-jugis, oblongo-linearibus, aristato-mucronatis; glandula paullo supra medium petioli subsessili; pedicellis supra-axillaribus, fasciculatis; staminibus 10, valde inaequalibus"; and added the note "Sufficiently distinguished from the preceding species (i.e. *Cassia mimosoides* L.) by the darker colour of the stems and foliage, the much larger leaves, shorter pedicel, and the different shape and position of the petiolar gland."

In Flora British India, vol. II, Baker placed *Cassia Wallichiana* as a variety of *Cassia mimosoides*. Trimen, in the Handbook of the Flora of Ceylon, adopted the same view, doubtless following the Flora British India, since he noted that he would prefer, with Thwaites, to regard it as a distinct species. He stated, "it is a very common weed about Kandy, and very distinct in appearance, having red-purple stems and blue-green foliage."

The above is the only form of *Cassia mimosoides* which occurs at Peradeniya. At higher elevations, *e.g.*, at Hakgala, var. *auricoma* is common, but this dies out when cultivated at Peradeniya. Thwaites C. P. 1510, which is accepted as the typical plant, is also from an upcountry district.

Some years ago, seed of *Cassia mimosoides* was brought in from India for trial as a green manure, and the resulting plants were so different from the common Ceylon var. *Wallichiana* that observations were made with a view to re-establishing the latter as a species, if possible. A subsequent reference to the literature, however, showed that Indian official botanists had already decided that *Cassia mimosoides* var. *Wallichiana* was worthy of specific rank, though it was still carried on in Ceylon lists under the old varietal name.

King, in "Materials for a Flora of the Malay Peninsula" (Jour. Asiatic Soc. Bengal, LXVI, 1897), distinguished var. *Wallichiana* as *Cassia Leschenaultiana*, and gave the following differences.

Cassia mimosoides. Leaflets linear, minute, ('15 inch long) ; pedicel 1 inch, bracteolate above the middle ; pod 20-25-seeded ; stamens all fertile, alternately long and short.

Cassia Leschenaultiana. Leaflets oblong, ('4 inches long, ·15 inches wide); pedicels ·3 inches, bracteolate below middle ; pod 8-16-seeded ; stamens unequal, one to three upper often sterile.

In "Some Additional Leguminosae" (Jour. Asiatic Soc. Bengal, LXVI, pt. II. No. 2, 1897), Prain published the following note on *Cassia mimosoides.*

"Var. 2. *Wallichiana*, as to *citation*, consists of two very distinct plants, both of which, as it happens, are mixed under Wall. Cat. 5320.

"One of these is the same plant as *C. myriophylla* Wall. Cat. 5326—and is no doubt a mere variety of *C. mimosoides* distinguishable, with difficulty in many cases, by its rather longer leaflets. Like the type it has small flowers with apparently always ten stamens, and has the petiolar gland deeply embedded in the leaf stalk.

"The other is the plant described by Mr. Baker as var. *Wallichiana*, easily distinguished by its larger flowers ; in this plant often only nine, sometimes only seven, of the stamens are perfect, and the petiolar gland, though not stalked, protrudes distinctly above the upper surface of the leaf stalk. The best name for the species is *C. Leschenaultiana* DC.

"Var. 3 *auricoma* is only a more hirsute condition of the preceding. It is equivalent to *C. Macraei*, but it should not be separated as more than a variety from *C. Leschenaultiana.*"

The name to be adopted for the Ceylon plant which was considered distinct by Thwaites and Trimen is consequently *Cassia Leschenaultiana.* But what passes for *Cassia mimosoides* var. *auricoma* in Ceylon is certainly not a variety of *C. Leschenaultiana.*

Cassia Leschenaultiana (Fig. 1) is common in the neighbourhood of Peradeniya. It is erect, with a stout stem up to 5 mm. diameter, sparingly branched above, with suberect branches, and attains a height of two-and-a-half, or sometimes three, feet. It is notable among the smaller Cassias for its intense coloration, its stems being deep purple-red and its leaves dark blue-green. The leaves appear uniformly green, whereas in *C. mimosoides* the leaves, at least when young, appear to have a pale band bordering the rachis on either side, *i. e.*, the bases of the leaflets appear to be paler than the outer parts.

In outline, the leaf of *C. Leschenaultiana* is ovate, the length of the leaflets in the same leaf varying from 10 to 16 mm. In a typical leaf, the length of the leaflets, eighteen in number, on one side, (ignoring the terminal bristle), were, beginning from the base, 11, 13, 15, 15·5, 16, 16, 16,

15·5, 15·5, 15, 15, 14, 13, 13, 12, 11, 10, 10 mm. respectively. The lowest leaflets are almost perpendicular to the rachis, while those in the middle make an angle of about 65° with it.

In *Cassia mimosoides* the leaf is parallel-sided (Fig. 2), the leaflets are about 1 mm. broad, and the acute tip is in continuation of the upper edge. In *C. Leschenaultiana*, the leaflets are up to 3 mm. broad, with a bristle-like tip about 1mm. long, situated below the upper edge (Fig. 3).

The outstanding difference between *Cassia Leschenaultiana* and *Cassia mimosoides* is the shape of the gland of the petiole, as noted by Thwaites. The position of the gland is also different, as a rule, in the two species, though the difference is not sufficiently constant to be diagnostic. In *Cassia mimosoides*, the gland is situated so that its upper edge is at the level of the insertion of the lowest leaflets, or it may be half a millimetre below that. In *Cassia Leschenaultiana*, the gland, if only one is present, is about two millimetres below the lowest pair of leaflets, but if, as frequently happens, two glands are present, one of them is situated in the first position noted for *Cassia mimosoides*.

The gland of *Cassia mimosoides* is sessile, oval in plan, and pulvinate (Fig. 5). That of *C. Leschenaultiana* is bucket-shaped, being circular in plan, with sides gradually sloping outwards, like an inverted truncate cone, and usually slightly concave on the upper surface (Fig. 4).

In *Cassia Leschenaultiana* the sepals are yellow, with a yellow-green stripe down the centre. In general, they are reflexed when the flower opens. The petals are orange-yellow, and the two upper* have a red spot at the base. The open flower is cup-shaped, and up to 12 mm. in diameter.

The flowers are either right- or left-styled on the same plant. Only one flower of a cluster is open at one time. Sometimes all the flowers which are open at the same time on a given branch are either all right-styled or all left-styled, but more usually both right- and left-styled flowers are open on the same branch at any given time.

The number of perfect stamens varies from eight to ten, but is usually ten. A count of 118 flowers gave 103 with ten stamens, 14 with nine stamens and one staminode, and 1 with eight stamens and two staminodes. The stamens are arranged in two whorls, the five of the inner whorl being shorter that those of the outer. The five stamens of the outer whorl are not all the same length ; two are about 7 mm. long, one about 5 mm., and the remaining two about 4·5 mm. Those of the inner whorl are more approximately equal, varying in the same flower from 3 to 3·5 mm. In the right-styled flower, as seen when fully

*The terms upper and lower are used here with reference to position as seen in the expanded flower.

expanded, the lowest stamen of the outer whorl is 7 mm. long, with a purple-red anther, yellow towards the base, and a yellow filament. Proceeding clockwise round the flower, the next stamen of the outer whorl is like the first, but the third, though its coloration is the same, is only 5 mm. long. The remaining two stamens of the outer whorl are 4·5 mm. long, and have yellow anthers, tipped with purple-red, and purple-red filaments. Thus in these two, the coloration of anther and filament is reversed. The five stamens of the inner whorl are yellow, slightly tipped and streaked with purple red. When the number of perfect stamens is less than ten, one, or both, of the two lowest stamens of theinner whorl is reduced to a staminode. The staminode is, as a rule, linear, ending in a fine point, but sometimes it terminates in a short, obconic, two-pored, anther-like tip.

The arrangement of the stamens in the expanded flower is as follows. The three longer stamens of the outer whorl follow the curve of the petals. The lowest of these runs more or less alongside the pistil, diverging slightly from it, and sometimes curving at the tip so that the open end of the anther almost touches the stigma. The other two form a similar pair, diametrically opposite, so that the three stamens and the pistil together form an acute-angled cross lying obliquely across the flower (Fig. 6). The two remaining shorter stamens bend together over the centre of the flower, almost perpendicular to the pistil. Of the stamens of the inner whorl, three follow the pair of long, coloured stamens which form one side of the cross, one follows the paired stamen and pistil which form the other side, and the remaining one follows the shortest, paired, yellow stamens of the outer whorl. Alternatively, both the latter stamens of the inner whorl may follow the paired stamen and pistil.

This is evidently the flower considered under *Cassia Leschenaultiana* in Knuth, Handbuch der Blutenbiologie, III, Part I, p. 373, The diameter of the flower is there given as 12 cm., but, as it is stated that it is one of the small-flowered species, that measurement is probably an error for 12 mm. In accordance with Knuth's classification, the three longest stamens are there regarded as pollinating stamens and the other seven as catering stamens.

Cassia mimosoides

Typical *Cassia mimosoides* does not appear to be common in Ceylon. Thwaites' specimens were obtained in Pussellawa (? Uda Pussellawa) and Maturatta, and there is a specimen in Herb. Peradeniya collected by Smith at Bandarawela. I have found it growing luxuriantly in Uda Pussellawa, at an elevation of about 5000 ft., but it has not been collected at Hakgala (5600 ft.). With the exception of Pussellawa, which may

be an error for Uda Pussellawa, all these localities are outlying districts on the eastern edge of the central hills, *i. e.*, on the drier side.

In Uda Pussellawa, *Cassia mimosoides* sprawls over the ground with branches up to three feet in length, and a semi-shrubby growth in the centre of the plant, eight inches or so high. Its leaves and stems are rather pale green. Its leaves are long, narrow, and parallel-sided, up to 9 cm. long, with leaflets about 3 mm. long and 0·8 mm. broad. The consecutive leaflets, forty-seven in number, on one side of a typical leaf, from the base to the apex, measured 2·5, 3·25, 3·5, 3·75, 3·75, twenty-nine 4. 3·75, 3·75, five 3·5, 3·25, 3·25, 3, 3, 2·5, 2, to the nearest quarter millimetre.

The flower is up to 1 cm. in diameter. The sepals are red-brown down the centre, and the petals yellow, without any red spot. In most of the flowers examined, the stamens are all yellow, except for a faint reddish edge to the pores, but occasionally one of the outer whorl is slightly streaked with red. Of thirty-four flowers in which the stamens were counted all had ten stamens. Measurements on one flower showed the stamens of the outer whorl to be 5, 5, 5·5, 5, 4·5 mm. in length respectively, and those of the inner whorl, all 4 mm long. The pistil is median, and the stamens are irregularly curved, but more or less erect.

The bracts on the pedicel are distant from the flower. When in fruit, the tips of the bracts do not reach to the base of the pod, but terminate 1 to 1·5 mm. below it. The gland on the leaf stalk is situated just below the point of insertion of the lowest pair of leaflets, so that its upper edge is at the level of the point of insertion.

Cassia mimosoides var. auricoma

Cassia mimosoides var. *auricoma*, following the nomenclature of the "Flora of Ceylon," is common at Hakgala, but is a small plant there, with a procumbent stem, very slightly branched, and seldom more than eight inches long. In Uda Pussellawa, it is much larger, and has the habit and dimensions of *C. mimosoides*. It grows with the latter, but is immediately distinguishable in the field by its darker leaves and stouter stems, the latter being purple-red on the exposed side.

The leaves, as a rule, are parallel-sided, though in some cases they taper slightly towards the apex. They are shorter than those of *C. mimosoides*, usually about 5 cm. long, with leaflets 6-7 mm. long and about 1 mm. broad. The lengths of the successive leaflets, twenty-four in number, on one side of a leaf from the base upwards were 4·5, 5·5, 6, 6, 6·25, 6·5, 6·5, 6·5, 6·5, 6·5, 6·5, 6·5, 6·5, 6·25, 6, 6, 6, 6, 5·5, 5·5, 5·5, 5, 4·5, 4·5 respectively. The gland on the leaf stalk is of the same shape as that of typical *C. mimosoides*, but rather larger, and it

is situated either in the same position, or with its upper edge up to half a millimetre below the point of insertion of the lowest pair of leaflets.

The flower is about 6 mm. in diameter. The sepals are red-brown down the centre, and are not reflexed. The petals are yellow, without any red spot. The stamens are usually seven in number, with from one to three staminodes. One staminode is either rudimentary, or linear, and up to 2 mm. long ; its apex is usually acute, but it may be slightly expanded and compressed, and sometimes, though rarely, it resembles the other two. This staminode is situated at the lowest point of the flower, and represents the lowest stamen of the outer whorl. The other two staminodes are intermediate in character, and might be regarded as short stamens. They are about 2·5 mm. high, with a filament about half that length which expands above into an obconic, anther-like structure furnished with two apical pores. They differ from the stamens in the gradual transition upwards from filament to anther. These represent the two lowest stamens of the inner whorl. In some cases all the three staminodes are linear, in others two of them. Out of thirty-nine flowers, three had all three staminodes linear, and eight two of them linear ; in sixteen flowers one staminode was wanting, and in thirteen, two were absent. As a rule, when the full complement of staminodes is not present, it is those of the inner whorl which have disappeared. The linear staminode of the outer whorl is usually present.

An examination of seventy-seven flowers gave the following results.

9 stamens	1 staminode	2	flowers
8 stamens	2 staminodes	4	,,
8 stamens	1 staminode	3	,,
7 stamens	3 staminodes	22	,,
7 stamens	2 staminodes	16	,,
7 stamens	1 staminode	18	,,
6 stamens	3 staminodes	5	,,
6 stamens	2 staminodes	5	,,
6 stamens	1 staminode	1	,,
6 stamens	no staminodes	1	,,

The most usual number of perfect stamens is thus seven.

The pistil practically median, but the flowers are nevertheless right and left-handed. Of the four stamens of the outer whorl, two are highly coloured, purple-red, while the other two are yellow or slightly streaked. The two former are situated, either both on the right, or both on the left of the flower. Of the other two, the uppermost bends forward until its tip almost touches the stigma. All the other stamens stand more or less erect from the base of the flower. The stamens of the outer whorl differ in length, and one usually appears longer than the

others, but it is not always the longest which bends towards the stigma. In one flower in which the two coloured stamens were on the right, the lengths of the stamens of the outer whorl, beginning with the lowest on the left and proceeding clockwise were 4 mm., 5 mm., 4·25 mm., 4·25 mm.; in this case the stamen which curved forward was the longest (5 mm.). In another flower of the same structure, the lengths of the stamens were 4·5, 4·5, 5, 5 mm., so that the curved stamen was one of the shorter (4·5 mm.). In another flower, with the two coloured stamens on the left, the lengths were 4·2, 3·5, 3·5, 4·0 mm.; here again, the curved stamen (No. 3) was one of the shorter.

The filaments of the outer whorl of stamens are longer than those of *Cassia Leschenaultiana*, and vary from 1·5 to 0·75 mm. in length. The stamens of the inner whorl vary from 3·25 to 2·5 mm. in length and have filaments about 0·5 mm. long.

The Ceylon form known as var. *auricoma* agrees with *Cassia mimosoides* in the shape of the gland. If therefore *Cassia Leschenaultiana* is distinguished from *C. mimosoides* on the shape of the gland, the Ceylon var. *auricoma* must be regarded as a variety of the latter. But it differs from both *Cassia mimosoides* and *Cassia Leschenaultiana*, as known in Ceylon, in the smaller average number of stamens, and in this respect it agrees with *Cassia Leschenaultiana* as described by Prain.

The Indian form cultivated at Peradeniya agreed with the Ceylon var. *auricoma*. The number of perfect stamens was usually seven, that number occuring in eighty out of one hundred and four flowers examined. Like the Ceylon var. *auricoma* it did not flourish at Peradeniya, and died out in the third generation.

Thwaites considered that the Ceylon var. *auricoma* was probably worthy of specific rank on account of the position of the gland, and of the bracts on the pedicel. He stated that var. *auricoma* (*villosula*) had the bracts nearer the base of the flower than in the typical form of *C. mimosoides*, and the gland a little below, instead of between, the lowest pair of leaflets.

The latter feature is variable in var. *auricoma*, and the upper edge of the gland may reach the point of insertion of the lowest pair of leaflets, or be 0·5 mm. below that, on specimens from the same locality.

The position of the bracts is best judged when the plant is in fruit. In *Cassia mimosoides*, the tips of the bracts, as a rule, do not reach the base of the pod, but terminate about 1 or 1·5 mm. below it. In var. *auricoma* they extend up to, or above, the base of the pod. But specimens of the latter from Hakgala have the bracts in either position on the same plant.

It would appear, therefore, that var. *auricoma* cannot be separated from *C. mimosoides* proper on either of the characters enumerated by Thwaites.

EXPLANATION OF PLATE XII.

Fig. 1. *Cassia Leschenaultiana*, × $\frac{3}{4}$.
Fig. 2. Leaf of *C. mimosoides* × $\frac{3}{4}$.
Fig. 3. Leaflets of *C. Leschenaultiana* (upper), and *C. mimosoides* (lower) × $1\frac{1}{2}$.
Fig. 4. Gland of *C. Leschenaultiana*, × 4.
Fig. 5. Gland of *C. mimosoides*. × 9.
Fig. 6. The three long stamens and the pistil of *C. Leschenaultiana*, × 4.

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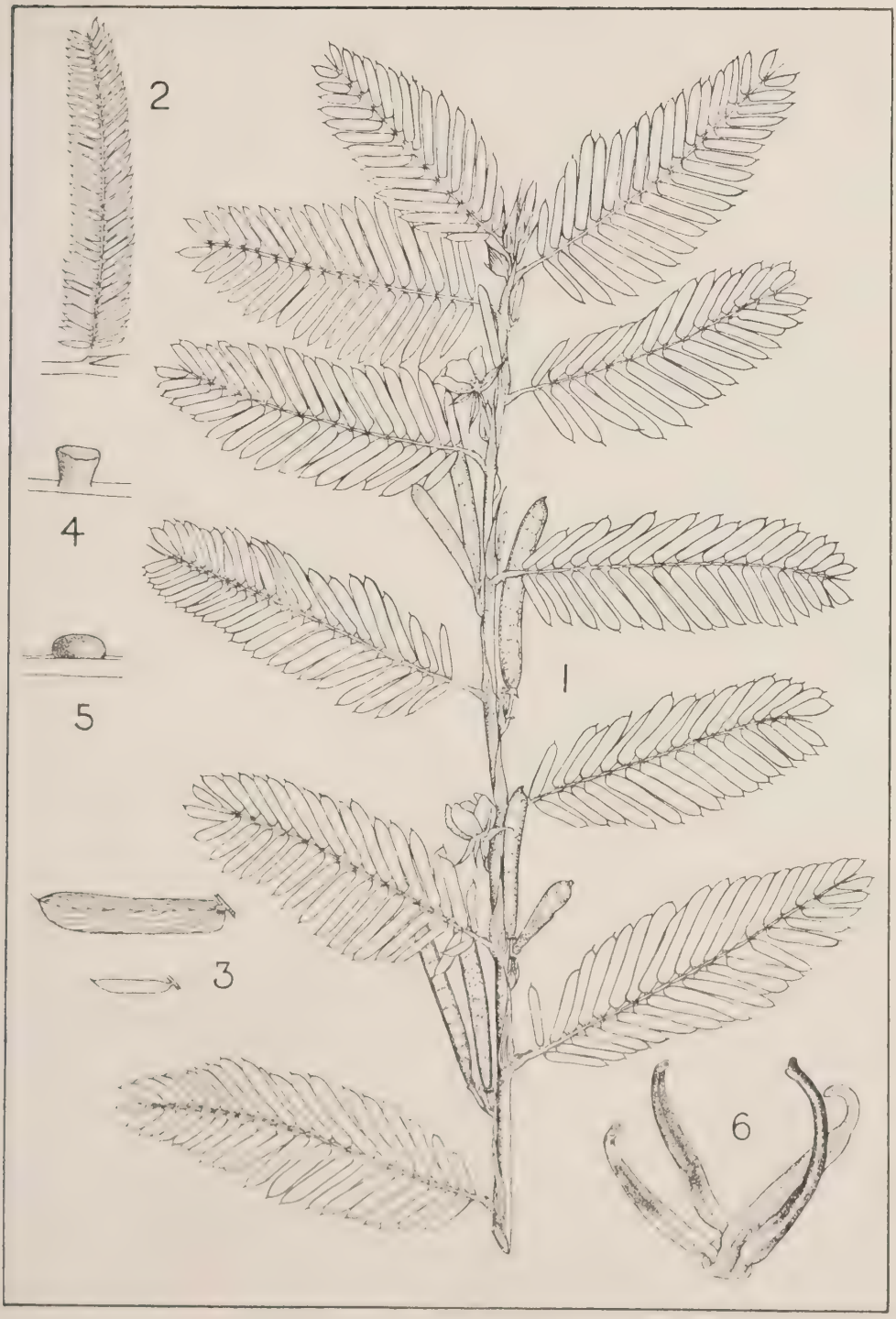
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Meristic Variation in Loranthus

BY

T. Petch, B.A., B.Sc.

A few years ago, a specimen of *Loranthus ligulatus* Thw., sent in for identification from the Mannar district, was found to bear several flowers with six petals (corolla segments) in place of the normal five. Subsequently other flowers of this species, and those of other species of *Loranthus*, were examined in order to determine to what extent meristic variation occurred in the flowers of this genus in Ceylon.

Loranthus cuneatus Heyne

This is a common species in Ceylon in both the wet and the dry regions, and occurs also in South India. Specimens were collected at Peradeniya in March-April 1923, and examined by Mr. E. J. Livera.

5 petals, 5 stamens	1171
6 petals, 6 stamens	1

Loranthus ligulatus Thw.

This is a rare Ceylon endemic, which occurs in the northern part of the dry zone, chiefly on *Salvadora*. Flowers were collected from a number of plants at Mannar in February, 1923. Counts of the petals and stamens gave the following results.—

4 petals, 4 stamens	3	flowers
5 petals, 5 stamens	1324	..
5 petals, 6 stamens	1	
6 petals, 5 stamens	1	..
6 petals, 6 stamens	12	..

Out of a total of 1341 flowers, 17, or 1·27 per cent., differed from the normal. The variation was chiefly in the direction of an increase in the number of parts.

Loranthus loniceroides L.

This species occurs in Ceylon and South India. Flowers were collected at Hakgala in February-March, 1922. They were consequently the up-country variety, which, as noted by Trimen, may be a different species from the plant named by Linnaeus which Hermann collected

in the low-country. I have not seen low-country specimens. The Hakgala form is notable for the thickened lobes of the corolla, which in bud form a hard, bluish grey or slate-coloured, conical tip. The flowers gathered from eight plants gave the following numbers,—

5 petals, 5 stamens	2	flowers
6 petals, 6 stamens,	1045	,,

The variation in this species is very small, and only abnormal flowers with a reduced number of parts were found.

Loranthus longiflorus Desrouss.

This species occurs in Ceylon, India, and Malaya. Flowers were collected at Mannar (near sea level, dry zone) in February 1923, at Peradeniya (1600 ft) during December 1921, from a plant on Pumelo, and at Hakgala (5600 ft) in February-March, 1922, from seven plants. The Hakgala form is assigned to var. *amplexifolius*. The count of the Mannar specimens was made by Mr. E. J. Livera.

	Mannar	Peradeniya	Hakgala
3 petals, 3 stamens	—	2	—
4 petals, 4 stamens	—	4	5
5 petals, 5 stamens	399	492	535
6 petals, 6 stamens	—	1	2

The variation is principally in the direction of a reduction of parts. The Mannar specimens showed no variation, the Peradeniya specimens 1·4 per cent. and the Hakgala specimens 1·3 per cent. The variation of the total number was slightly below 1 per cent.

Loranthus neelgherrensis W. & A.

This species occurs in South India and Ceylon, and is common in the latter country up to an elevation of 7000 feet. It is very common on fruit trees at Peradeniya. Specimens were collected at Peradeniya on Pumelo and on Mango in December 1921, on tea, cacao, etc., in the same locality in March 1923, and on Acacia at Hakgala in February-March, 1922. Counts of the 1923 Peradeniya specimens were made by Mr. E. J. Livera.

	Peradeniya 1921.	Peradeniya 1923.	Hakgala.
3 petals, 3 stamens	2	—	—
4 petals, 4 stamens	23	5	11
4 petals, 5 stamens	1	—	—
5 petals, 5 stamens	1043	333	753
5 petals, 6 stamens	1	—	—
6 petals, 5 stamens	1	—	1
6 petals 6 stamens,	5	—	2

The variation is again principally a reduction. At Peradeniya, 3·07 per cent. of the first collection and 1·8 per cent. of the second, and at Hakgala 1·83 per cent., of the flowers showed variation. The combined results give a percentage of 2·28. 7·7 per cent. of the abnormal flowers showed unequal variation of the petals and stamens.

Loranthus sclerophyllus Thwaites

A Ceylon endemic. Specimens were gathered at Hakgala in February-March 1922, from three plants.

5 petals, 5 stamens	840
6 petals, 5 stamens	1
6 petals, 6 stamens	18
7 petals, 7 stamens	1

The variation, as shown by these specimens, is solely in the direction of an increase of parts. 2·34 per cent. of the flowers showed variation.

Loranthus suborbicularis Thw.

A Ceylon endemic. Specimens were collected from several plants on *Rhododendron* at Hakgala in February-March, 1922, and in September 1923.

4 petals, 4 stamens	2
5 petals, 5 stamens	927

Loranthus tomentosus Heyne var. **incanus** Trimen.

Specimens were gathered at Hakgala in February-March, 1922.

4 petals, 4 stamens	24
5 petals, 5 stamens	653
6 petals, 6 stamens	5

3·96 per cent. of the flowers were abnormal. The variation was chiefly in the direction of a reduction of parts.

The variation in the flowers of *Loranthus* proved to be much smaller than had been expected. Three species, *L. cuneatus*, *L. loniceroides*, and *L. suborbicularis*, showed scarcely any modification from the normal in number of parts. The greatest variation occurred in *L. tomentosus* var. *incanus*, in which the abnormal flowers amounted to 3·96 per cent. *L. sclerophyllus* and *L. neelgherrensis* gave 2·34 and 2·28 per cent. respectively, *L. ligulatus* 1·27 per cent., and *L. longiflorus* slightly less than 1 per cent.

In general, the number of petals and stamens remained equal. Unequal numbers of stamens and petals were found only in 7 flowers out of a total of 10292.

Variation consisted principally of a reduction of parts. But in *L. ligulatus* the majority of the abnormal flowers, and in *L. sclerophyllus* all the abnormal flowers, had an increased number of parts.

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The Corm of Gloriosa superba

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE AND ONE TEXT FIGURE

One of the most striking of the Ceylon herbaceous plants is the liliaceous climber, *Gloriosa superba*, the Sinhalese Niyangala. It owes its scientific name to the eulogies bestowed upon it by the early botanists, Hermann styling it *Lilium superbum* and Burmann, *Methonica gloriosa*. Hence Linnaeus combined the two epithets in *Gloriosa superba*. The Sinhalese name is probably derived from Naga, a cobra, and ala, a yam, the corm being frequently employed in village cases of poisoning.

Apart from its beauty, which appeals even to the most casual visitor, *Gloriosa superba* offers many points of interest to the botanist, *e.g.*, its peculiar corm, its leaf tendrils, the colour changes of its remarkably reflexed perianth, the movement of the style relative to the stamens, etc. The present account deals with the first of these, and is the consequence of superintending the collection of over three hundredweights of corms for the purpose of pharmacological investigation.

Linnaeus, in Flora Zeylanica, described the corm as "Radix carnosa simplex, ad angulum rectum flexa," a more accurate description than those of later writers.

In Flora British India *Gloriosa superba* is said to have a rootstock consisting of a chain of fleshy arched tubers, budding from the convexity above. This suggests that the tubers are arched in a vertical plane, and that several occur in succession, like the customary representation of the sea serpent.

The description in the Handbook of the Flora of Ceylon is evidently a combination of that in Flora British India and manuscript notes by Trimen. It reads as follows,—"Rootstock of arched, solid, fleshy, white cylindric corms, 6-12 inches long, 1-1½ inches diameter, pointed at each end, bifurcately branched (or V-shaped), producing a new joint at the end of each branch." "Stem given off from the angle of the young corms (biennial, Roxb.)." The last statement is somewhat ambiguous; it is the corm which Roxburgh said was biennial.

The corm is composed of two arms which in the large majority are practically at right angles to one another. Cases do occur in which the angle is greater or less than a right angle, but these variations are apparently caused by obstructions in the soil. The arms are sub-cylindric, tapering to a blunt point at the tip, and may, in large specimens, be somewhat contracted towards the junction. In general one arm is much longer than the other, for example, 10.5 and 5.5 cms. respectively, but in very large corms, the two arms approach equality. The largest corm I have seen had arms 18.5 and 18 cms. long respectively. In general shape, the corm recalls the conventional figure of a boomerang, but the two arms are, unless distorted by stones, etc., in the soil, practically at right angles. The corm lies horizontally in the ground, with the two arms in the same horizontal plane, and the stem is attached to the upper surface of the corm at the junction of the arms (fig. 1).

Variation in the shape of the corm occurs especially in small specimens. Small plants which grow to a height of two inches or so above the ground and then die down, have globose corms about the size of a pea. Others, somewhat larger, may have simple conical corms, about 2 cms. long, lying horizontally in the soil (fig. 2). But when a corm has attained a length of about 4 cms., it usually exhibits the normal rectangular shape, with one long and one short arm. It is probable that the very small plants are not far removed from the seedling stage.

The corm is white at first, but soon acquires a brown, separable skin. In general, when the corm is dug up, it is brown, except near the tips of the arms.

Interest was aroused by the peculiar shape of the corm, and the attachment of the stem in a position where one would not have expected to find a growing point ; and consequently observations were made to determine how the new corm arose from its predecessors. This point is immediately decided on digging up young plants, in which the stem has attained a height of about a foot. It is then seen that the new corm arises at the tip of one of the arms of the old corm, the apex of the angle of the new corm being united to the tip of the arm of the old corm. From small corms, a new corm arises, as a rule, from the tip of one arm only. The larger corms may produce a new corm at the tip of each arm (fig. 1). But when only one new corm grows from the old one, it is invariably at the end of the longer arm ; while if the old corm produces a new corm at each end, that at the end of the longer arm develops first. The longer arm is physiologically and morphologically the older.

Thus, the " rootstock " of *Gloriosa*, when the plant is young, consists of an old corm, and a new corm united to it, the aerial stem being attached to the latter ; or, at the most, of an old corm, with a new corm

at each end, each of the latter bearing an aerial stem. As the aerial parts of the plant grow larger the reserve food of the old corm is consumed or transferred, and the corm decays, so that finally one, or in the second of the cases noted above, two, plants are left, each attached to an isolated corm. The parent plant cannot give rise, vegetatively, to more than two plants in one generation. All these corms lie in the same horizontal plane, except under abnormal circumstances which will be detailed later.

A variation of the foregoing sometimes occurs in nature, and may be induced by appropriate treatment. The stem of *Gloriosa* remains unbranched for a considerable distance from the base. If the apical growing point of a leafy aerial stem, up to at least two feet high, is destroyed, it is unable to produce lateral buds and consequently does not grow further, remaining in that condition for a long time and ultimately dying down. This frequently happens in nature, the upper part of the stem being destroyed by caterpillars or eaten off by animals. In general the new corm continues to develop, and all the reserve material of the old corm passes over into the new one, the latter then remaining dormant until the next season, when it sends up a new stem. In some cases, however, when the stem has been bitten off at ground level, the new corm sends up a new stem, with the consequent formation of another corm, before the original corm is exhausted. In that case, three generations of corms may be found connected with one another (Fig.3). This may result from transplanting young plants, owing to the death of the original aerial stem. The aerial part of *Gloriosa*, in my experience, rarely survives transplanting, in spite of the fact that it arises from a corm.

The position of the new corm relatively to the old one is subject to two rules, (1) the longer arm of the new corm lies in the same straight line as the arm of the old corm from which it arose, and (2), the shorter arm of the new corm points in the direction opposite to that of the other arm of the old corm.

Take for example the case of a corm, of which the longer arm (A) points to the north and the shorter arm (B) to the west. The new corm which arises at the tip of (A) will have its longer arm pointing to the north and its shorter arm to the east. If a new corm also develops from the tip of (B) this will have its longer arm pointing to the west and its shorter arm to the south. If this be plotted out on paper, it will be seen that, if the arms of the corms were equal, and a new corm of the same dimensions developed at the end of each arm, then in the fourth generation there would be eight corms, four widely separated, and the other four in pairs, each pair forming a square with their apices in contact. However, as already stated, neither of these conditions is fulfilled. The

arms of the corm are usually unequal in length, and a new corm may arise only at the end of the longer arm ; or if two new corms develop that at the end of the shorter arm is later and smaller.

The development of the new corm is easily followed in the laboratory. A plant is dug up and the stem cut off, or the stem may be allowed to die naturally. The corm is then left lying on the table. If the corm is white, *i.e.*, if it has not yet developed its outer, brown, separable skin, the latter is soon formed under these conditions. In a short time, sometimes within a few days, a line or groove will be noted at the tip of the longer arm, demarcating a more or less triangular area,extending backwards from the tip on the upper surface of the corm, like a finger nail. Beneath this area lies the tissue containing the new bud, which consists of a small thick scale turned backwards from the tip of the arm. If the apex of the corm is more or less acute, this scale lies on the upper surface ; if however it is very obtuse, the scale is situated more vertically at the end of the arm and does not extend so far over the upper surface. This scale is not evident macroscopically on the fresh corm, but under the conditions stated it begins to increase in thickness and is consequently indicated by the raising of the outer brown coat. The outer coat is subsequently ruptured, and the scale becomes erect, increasing in thickness so that both surfaces become convex, and growing downwards below its point of attachment to the corm (Fig. 5).

Roots now begin to develop at the base of the scale, but unless supplied with water they usually remain short, 1-2 mm. long, or they may fail to break through the initial root prominences. From this point, the further course of development varies. The scale may rupture at the apex, and a shoot grow out to a length of six or eight inches, the scale forming the first scale leaf ; or nothing further may occur except an increased thickening of the scale, often accompanied by a bifurcation at the apex. Fig. 6 shows a specimen in which the scale has thickened, but the shoot is emerging through the convex upper surface ; while Fig. 7 shows a case in which the scale has thickened and bifurcated. Plants may remain dormant in this condition. If, however, the corm is placed so that its developing roots dip into water, the roots lengthen, and the shoot bursts through the apex of the scale and develops normally. Plants may be maintained in water culture in this way for several months ; they have been grown to a length of 210 cms. in water culture in the laboratory, but have not flowered under these conditions.

It is to be noted that the first stages of development are obtained by allowing the corm to dry ; and a shoot may be produced, up to 8 inches high, while the corm is lying on the laboratory table. The roots, however, remain rudimentary under these conditions. To cause the

elongation of the roots, and to ensure the development of the shoot, water must be supplied after the roots appear. If that is not done, the new plant may become dormant.

Fig. 8 shows a vertical longitudinal section, not quite median, through the tip of the corm after the scale has become evident. The tip in this case is obtuse, and the scale which contains the bud is vertical. The outer brown coat has been removed, but the scale is not superficial, being covered by a thin layer which is attached immediately below the scale and is continued over to the upper surface where it ends in a free edge, not shown in the figure.

Fig. 9 shows the corresponding section in a similar corm in an older stage. The outer brown skin is wanting, as is also the layer which covered the scale in the earlier stage. The scale now consists of a series of closed sheaths, enclosing the bud, and the outermost of these sheaths is continuous with a mass of parenchyma in the angle between the scale and the corm, which in turn is continuous with a thin layer split off from the upper surface of the corm. The line of cleavage of this latter layer does not proceed far, and in the specimen in question the layer does not end in a free edge.

Both the foregoing sections were taken from examples developed naturally, not in the laboratory.

When the scale thickens abnormally, as already described, under laboratory conditions, the thickening is due to a development of parenchymous tissue on the inner side of the scale.

Several sheathing scale leaves are produced in succession before the normal leaves appear. In this, the "spear" stage, the young plant has a slightly swollen base. If the bud scale was more or less vertical, the young plant is attached laterally, a little distance above its roots, to the apex of the corm (fig. 10); but if the scale was situated more horizontally along the upper surface of the old corm, the new plant is perched on the top of the latter (fig. 11). By the time the normal leaves appear, or sometimes before that, the swollen base begins to bulge out on the side opposite the point of attachment to the parent corm. This swelling is the first indication of the development of the longer arm of the new corm, and growth continues uniformly in that direction, *i.e.*, in the same straight line as the longer arm of the parent corm (Fig. 11). Some time later, a similar swelling occurs at the base of the stem, in the same horizontal plane as the former, but in a direction at right angles to it, and by further growth in this direction the shorter arm of the new corm is formed.

Judging from plants dug up at various stages, the development of the corm is not completed until the aerial parts of the plants are

about to die down. On corms obtained from plants which are beginning to die, the distal end of at least the shorter arm may be still white. But the formation of the new corm begins soon after the appearance of the aerial stem.

The initial bud of the new plant is evidently part of the parent corm. By the time it has become erect, it appears quite distinct from the old corm ; and by further development of its base, the latter becomes the new corm, so that the stem appears to arise from the new corm. Thus, when a plant is dug up and found to have only a single corm, the latter is the new corm in process of formation, not the corm from which the stem originally arose.

The two branches of the new corm and the aerial stem lie along three lines at right angles to one another. This ternate branching is repeated in the aerial stem, but the branches of the stem do not, as a rule, develop equally, and the angles between the branches are variable.

It will be evident that the corm of *Gloriosa* does not produce a bud "from the convexity," *i.e.* from the angle of the corm, but that, conversely, the bud produces the corm at its base. The bud arises from the apex of the arm of the old corm ; and the corm to which the stem is attached is the new corm in course of formation by the enlargement of the base of the stem. The two arms of the new corm may be regarded as two lateral branches.

Corms left drying on the laboratory table start into growth much more rapidly than those planted in the open or in pots. Two plants were dug up on December 20th, 1921. Plant A had a partially collapsed old corm, with arms 9 and 3.5 cms. long respectively, and a new corm, with arms 12 and 6 cm., from which a stem 60 cms. high arose: the new corm was still white and the plant had not approached the flowering stage. Plant B had a partially collapsed old corm, with arms 4.5 and 3 cms. long respectively, and a new corm, with arms 6.5. and 4.5 cm., from which arose a stem 26 cms. high ; this corm was also white and the plant still younger than the previous one. The old corm and the aerial stem were removed in both cases, and the new corm of A was planted in a pot exposed to the weather, while that of B was left lying on the table. On January 26th, 1922, B was developing a bud, and on February 9th, this was erect and the roots were just visible. On February 18th, it was placed so that its rudimentary roots dipped into water, and in three days these grew to a length of 1 cm. A month later (March 17th) the new shoot was 50 cms. high and by April 7th both arms of a new corm were well-developed. A, however, did not produce a new shoot until the first week in September.

Three small plants with new corms about 5 cms. long were planted in a bed on May 12th, 1921. The aerial stems of all three died shortly afterwards. A new shoot appeared from one plant on September 11th, but was eaten off a few days later. A second plant produced a shoot on November 7th, and the same fate befell this after it had attained a height of about six inches. Nothing further appeared until June 1922 when all three plants sent up new shoots. Thus, the first plant produced a shoot from the original corm planted in four months, and another from a corm subsequently developed in nine months. The second plant produced shoots from similar corms in six and seven months respectively. But the third did not produce a shoot from the original corm until after the expiration of thirteen months. Meanwhile a similar corm, dug up on June 12, 1921, and left on the laboratory table, had formed a new bud and was developing roots by July 29th, 1921.

A large corm, with arms 18.5 and 18 cms. long respectively, was dug up on May 28th, 1921. The plant had flowered and was dying. The corm was left on the table, and on May 30th, it was noted that one tip was splitting, *i.e.* the terminal scale or bud was beginning to grow. The significance of this separation was not realised at the time, and the corm was immediately placed, half embedded in soil, in a pot which was covered with a sheet of glass, the soil being kept moist. No further growth occurred up to February 23rd, 1922. Owing to my absence from February 23rd to March 13th, the soil became dry, it was watered again on the latter date. On March 27th, the scale at the tip of the longer arm was becoming erect, and on April 6th, it was developing roots. This tip was cut off on April 14th. On April 27th, the scale at the tip of the other arm became erect, and had developed roots by May 8th. On the latter date, this second growing point was cut off. The corm was then planted in a pot which was left exposed to the weather. In July 1923, it was dug up and found to be sound, but in March 1924 half the shorter arm was found to have decayed. The decayed part was cut off and the corm replanted. By July 1924, no further decay occurred, but by December 1924, the shorter arm had decayed completely and the rot had extended round the bend to the longer arm. During this period of two and a half years, there was no production of new buds.

There is no doubt that in the last case cited, the corm, if it had not been potted and watered, would have developed an erect bud and initial roots in about a month, and if it had then been supplied with water further development of the roots and shoot would have followed immediately. But planting the corm and watering it when the scale first began to separate stopped development for nearly a year.

It would not be correct to suppose that under natural conditions the corm must undergo a period of drying before it can produce a new shoot. New plants certainly appear when the rains begin in April, after the dry season, January to March. But they also spring up at any time from April to December, and during that period the corms have little chance of drying in the Peradeniya district.

The " forcing " of a corm by leaving it to dry has been done in all months from May to January. It has succeeded equally well with corms from plants which have flowered and are dying down, from large plants which have not flowered, and from small plants six inches high.

The development of shoots, etc., from bulbs or corms without the addition of water is a well-known phenomenon. Jost (Plant Physiology, English edition, p. 162) wrote " It is well-known, for instance, that potato tubers are able to develop shoots if not in too dry an atmosphere owing to their possessing a store of water, and that some bulbs and tubers may give rise to shoots bearing flowers, without any absorption of water being observable. Medicus (1803) noted this in the case of *Veltheimia capensis* ; Hildebrand (1884) drew attention to the same fact in *Oxalis lasiandra* ; and recently *Sauromatum guttatum* has been put on the market as a curiosity in consequence of its power of forming flowers in the complete absence of water, after being heated."

Fig 1. Plants Developed from Bulbils of *Crinum Moorei*.

The bulbils from the inflorescence of *Crinum Moorei* will produce a plant with bulb, shoot, and roots, while lying on the table in the laboratory. Text figure 1 shows three such plants, attached to the shrivelled bulbils. These were brought down from Hakgala (5,600 ft.), on September 21st, and left on the table in the laboratory at Peradeniya (1,600 ft.). The photograph was taken on December 9th. The bulbs were then up to 3 cms. in diameter. The longest shoot was 3.5 cm. long,

but had withered at the top, while the roots, up to 3 cm. long, had similarly withered. One example bore five withered roots, and was producing seven new ones.

It will have been noted that in the cases recorded of growth from the corms of *Gloriosa* in the laboratory the new bud begins to develop after a period varying from a few days to about a month. The dormant period of the corm is shortened or abolished. Shortening of the dormant period in potato tubers was experimentally induced by Schmid (Ber. d. Bot. Gesell., XIX, p. 76) who kept recently-harvested potatoes half embedded in sand in a greenhouse from October 21st, and obtained shoots with leaves by November 8th. Schmid concluded that the essential conditions for this forcing were a high temperature and ample aeration. His results however are not comparable with those obtained with *Gloriosa*, as the tubers were watered with a nutrient solution and evaporation was prevented by covering the pots with a glass plate.

Exposure to light does not appear to have any influence on this forcing of the corms. In the case of the large corm which was half embedded in soil after the initial separation of the scale, no further growth occurred for ten months, although it was exposed to light almost equally with the corms which were lying on the table. Similarly, this corm was subject to the same temperature as the others.

Pfeffer (Pflanzenphysiologie, III, p. 267) stated, "A temporary withering appears to favour the sprouting of bulbs of hyacinth and tulip, and corms of Crocus. It has not been definitely determined how far this depends upon the degree and duration of drying." It would appear that the present case is similar, and that this forcing of the corms of *Gloriosa* is to be attributed to the drying.

There is very little evidence of change in the contents of the corm at the time the new shoot and roots appear. Most of the cells near the growing point are then filled with starch grains, and there is a remarkable absence of any signs of corrosion. The drying does not induce a general conversion of the starch.

Gloriosa superba, for its full development, requires low shrubs over which it can climb. It is consequently associated with scrub jungle, or occurs along the jungle edge, or along roadsides, or is found as a weed in shrubberies. But it comes rather as a surprise to find that at Peradeniya it is a common constituent of the flora of open pasture land. Dozens of plants may be found among the grass in such situations. These plants remain small, not more than four inches or so high. Of course they never flower, but are propagated by the corms, which are

usually small, not more than about 5 cms. long. Many of these plants are eaten down, but whether by cattle or hares has not been ascertained. If they are eaten by cattle, the latter do not suffer in any way. It may be that the aerial parts are not poisonous, but the distribution of the poison in the plant does not appear to have been determined. In the case previously referred to (p.249), in which two young plants were eaten down, these were growing within a barbed wire fence and were not accessible to cattle.

Plants growing in grass at Peradeniya usually have their corms situated at a depth of about two inches. Those which spring up in a neighbouring tea estate where the ground is kept free from weeds, but the soil is compact, have their corms at the same depth. But in flower beds and shrubberies, where the soil is loose and periodically forked, the corms are at a depth of about seven inches. If a young plant is dug up and planted in a pot, the aerial stem, as already stated, usually dies, but the new corm continues to develop from the old corm. When the young plant has been taken from grass land, and planted at its normal depth in a pot, the part of the new corm which is subsequently developed turns vertically downwards.

Figure 3 is a lateral view of such an example. The corm to the right is the oldest corm, of which only part is shown. The plant was dug up when the new corm had grown to half its length, and planted in a pot. The aerial stem died, but the new corm continued to grow and both arms turned downwards. This corm subsequently produced new stems and corms at the ends of its arms, and these new corms were again directed downwards. Only one of the daughter corms of the third generation is shown in figure 3. Both are seen in figure 4, which is an end view of the same series of corms.

Conversely, if a corm is planted too deep, the new corm will be directed upwards (fig. 12).

When a plant left lying on the table develops a new corm, the latter points downwards. In the case of the plant grown to a length of 210 cm. in the laboratory, with only the roots originally immersed in water, both arms of the new corm turned vertically downwards into the water, the longer eventually reaching to the bottom of the beaker. The beaker was not darkened, but during the greater part of the period of formation of the corm it was beneath a table near a window and consequently in a weak light.

The foregoing facts indicate that the corms of *Gloriosa* grow at a definite level which varies with different soils. This point has not been

investigated further. The result obtained in water culture would appear to show that this level does not depend solely on the level of the water table.

The Flora of Ceylon states that *Gloriosa* flowers from September to January. At Peradeniya, January, February, and March are dry months, with an average rainfall of 3·74, 1·55, and 4·68 inches respectively. April is the month of the "Little Monsoon," with an average rainfall of 8·45 inches. May is drier (5·91 inches), but June and July are the rainy months of the south-west monsoon, with rainfalls of 11·03 and 8.31 inches respectively. The rainfall decreases again in August and September (6·04 and 6·72 inches), and increases again, owing to the rains of the north-east monsoon, during October, November, and December which have average rainfalls of 13·54, 10·41, and 8·56 inches.

At Peradeniya, plants of *Gloriosa* begin to spring up during the showery period at the end of March, and new ones continue to appear at any time until the following January. But the majority of the larger plants first appear above ground in August-September. In general, February and the first half of March is the period during which no new plants arise.

Plants of medium size may be found in flower at Peradeniya and in the wet low-country from June onwards, though the main flowering period is, as stated in the Flora of Ceylon, September to January. But plants which spring up late in the year will continue in flower during February and March, while those which appear in December and January will persist through the dry season and bloom in April and May. In the wet zone of Ceylon, *Gloriosa* may be found in flower, as a rule, throughout the year. The flowering season is prolonged because of the successive appearance of new plants at all times except during the driest months.

It is possible that in the dry zone of Ceylon, where the rainfall is limited principally to the north-east monsoon period, October-January, *Gloriosa* may exhibit a more definite general periodicity. The plant, however, is common in the wet zone, and cannot be classed as a dry zone species.

Flowering is dependent upon the size of the plant. As a rule, plants do not flower unless they attain a length of six feet or so. The size of the plant depends upon the size of the corm.

Small corms produce small plants which die down in a few months without flowering. Some of the small plants in open grass land are only two to three inches high, with a stem about a millimetre in diameter, and bear about half a dozen leaves crowded together. In these the spear barely appears, or does not appear, above ground. Others

may attain a height of a foot, with a stem about 2 mm. in diameter, bearing up to twenty leaves more widely separated. These small plants may die down in June and be succeeded by others from the daughter corms in September. As a rule, they are absent in the dry season. But plants of the same size in flower beds or on bare ground will persist through the dry season, though exposed to full sunlight. In 1922, small plants which appeared in December on bare ground near the new laboratories at Peradeniya survived the dry season of 1923, although no rain fell between January 26th and March 4th.

Large corms give rise to plants which may attain a length of 20 feet. The spear stage may be 2 ft. or 2 ft. 6 in. high, the upper part bearing rudimentary leaves, and the stem 8 mm. in diameter. The growth of these plants is rapid ; a plant which sprang up on July 28th had attained a length of 12 feet and had begun to flower on September 10th. These plants die after flowering, independently of the season when the flowering occurs ; that just referred to died in the first week in November.

It might, perhaps, have been expected that the dormant period of the corm would coincide with the dry season, and would be a short one of two or three months. For very small corms this would appear to be the case, as these small plants spring up in abundance at the commencement of the rains. But for the majority of the plants, especially the larger flowering examples, this does not hold good. Their dormant period includes, in general, the dry season, or the latter part of it, but it also extends through the rains of the south-west monsoon, and the majority of the new plants spring up in August-September, in the moderately wet period between the rainy months of the two monsoons. Moreover, some plants will retain their aerial stems through the dry season and flower when the rains begin.

In one case, a new corm planted in December produced a new shoot in September of the following year. A large plant which died, after flowering, in the middle of March, was succeeded by another in the middle of August. Another, of medium size, which died, after flowering, at the end of April, was followed by its successor on October 15th. A number of plants, grown together in the Botanic Gardens, which died, after flowering, in November-March, left corms which produced new plants in the following July-September. The period of dormancy of the corm is not necessarily related to the dry weather (January-March), and new plants do not all spring up together at the beginning of the rainy season.

In *Gloriosa*, the vegetative period, *i.e.* the formation of a long leafy stem, precedes the flowering period, in contrast to such species

as the crocus, in which the leaves and flowers appear almost simultaneously. The formation of the new corm begins almost as soon as the first leaves appear, and in some instances the new corm exceeds the old one in size before the stem is a foot high, though only when the stem has developed leaves. In cases already cited, one plant had arisen from an old corm, the arms of which were 9 and 3·5 cms. long respectively, and had developed a new corm, with arms 12 and 6 cms., by the time the stem was two feet high ; and another had arisen from an old corm, with arms 4·5 and 3 cms., and had developed a new corm with arms 6.5 and 4·5 cm., when the stem was ten inches high. Both these plants were about six weeks old and had few leaves. In such cases the new corm has evidently been formed chiefly at the expense of the reserve material in the old one. But other examples show a different relation ; in another case, a plant about ten weeks old which had originated from a corm the arms of which were 12 and 9 cm. in length, had developed a stem 7 ft. in length while the arms of the new corm were only 7 and 5 cm. respectively. In the latter case the plant bore many leaves, and the old corm was not collapsed. The development of the stem in this case was in advance of that of the corm.

It is known that if a plant is cut down at ground level at an early stage, the new corm continues to develop, and the reserve food of the old corm is transferred to the new one. Also, the small plants which cease aerial growth after producing a stem about a foot high do not exhaust the old corm in the formation of leaves and stem, and the excess reserve food is presumably similarly transferred to the new corm. In any case, the fact that the corms of these small plants increase in size in successive generations is evidence of a gain of reserve material in each generation, and that, under average conditions, cannot be obtained without the transfer of an excess on the formation of each new corm.

As an organ of propagation, the corm of *Gloriosa* is not very efficient, as at most only two daughter corms can be produced.

The presence of a corm in *Gloriosa* may be regarded to some extent as an adaptation to habitat. The plant grows normally among bushes or scrub jungle, over which it climbs. The corm enables it to produce a long initial shoot rapidly, and it thereby grows quickly through the bushes into a position in which its leaves will not be subject to excessive shading. But this is only applicable in the case of the larger corms.

It has already been shown that the period of dormancy of the corm is not confined to the dry season. Moreover, the aerial parts of the plant can survive the dry season over a great part of its range. Consequently it does not appear that the corm of *Gloriosa* can be regarded as an adaptation to climate.

Small corms produce plants which remain small and do not flower. It is only by the accumulation of reserve food through successive vegetative generations that the corms increase in size until they are large enough to produce flowering plants. The corm of *Gloriosa* is not necessarily able to produce a flowering stem, and the individual corm does not increase in size until it can. Increase in size of the corms (and the plants) comes with successive new corms, until finally a size is reached which will enable the next aerial shoot to flower. When that stage has been attained, the majority of the succeeding corms should, under normal conditions, give rise to flowering stems,—not all, because the corm, if any, produced at the end of the shorter arm may be too small.

It may be suggested that this function of accumulating the excess reserve food of successive (vegetative) generations is the fundamental explanation of the existence of corms in general, the adaptation to the seasons which is so evident in temperate climates being secondary.

It is not clear why the plants which develop from small corms should remain small. The size of the corm will govern the size of the terminal bud, and consequently the diameter of the aerial stem. The diameter of the stem increases upwards from the corm, but the stem does not undergo any subsequent thickening. Consequently the plant cannot develop a stouter stem. But there does not appear to be any obvious reason why the stem should not increase further in length, utilising the remainder of the reserve material in the corm. The suggestion that the growth of the aerial stem ceases when the new corm begins to develop is not supported by the observations which have been made in the laboratory and in the field.

The foregoing account is based chiefly on field observations, time not being available for detailed experiment. It will be evident that *Gloriosa* offers a wide field for physiological experiment, particularly as regards the relationship of the old and the new corm, and the aerial parts of the plant.

EXPLANATION OF PLATE XIII

(*Old Corm Marked* **X**)

Fig. 1. An old corm, producing a daughter corm at each end ; x 2/3.

Fig. 2. A small corm, producing a new corm at each end ; nat. size.

Fig. 3. Lateral view of three successive corms, the third and half the second being formed after transplanting and directed downwards because the old corm was not planted deep enough ; nat. size.

Fig. 4. End view of the same series of corms ; nat. size.

Fig. 5. Apex of old corm, showing bud scale ; x 2.

Fig. 6. Apex of old corm, with bud scale abnormally thickened, the shoot breaking through on the convex surface : developed by drying ; nat. size.

Fig. 7. Apex of old corm, with bifurcated scale ; developed by drying ; nat. size.

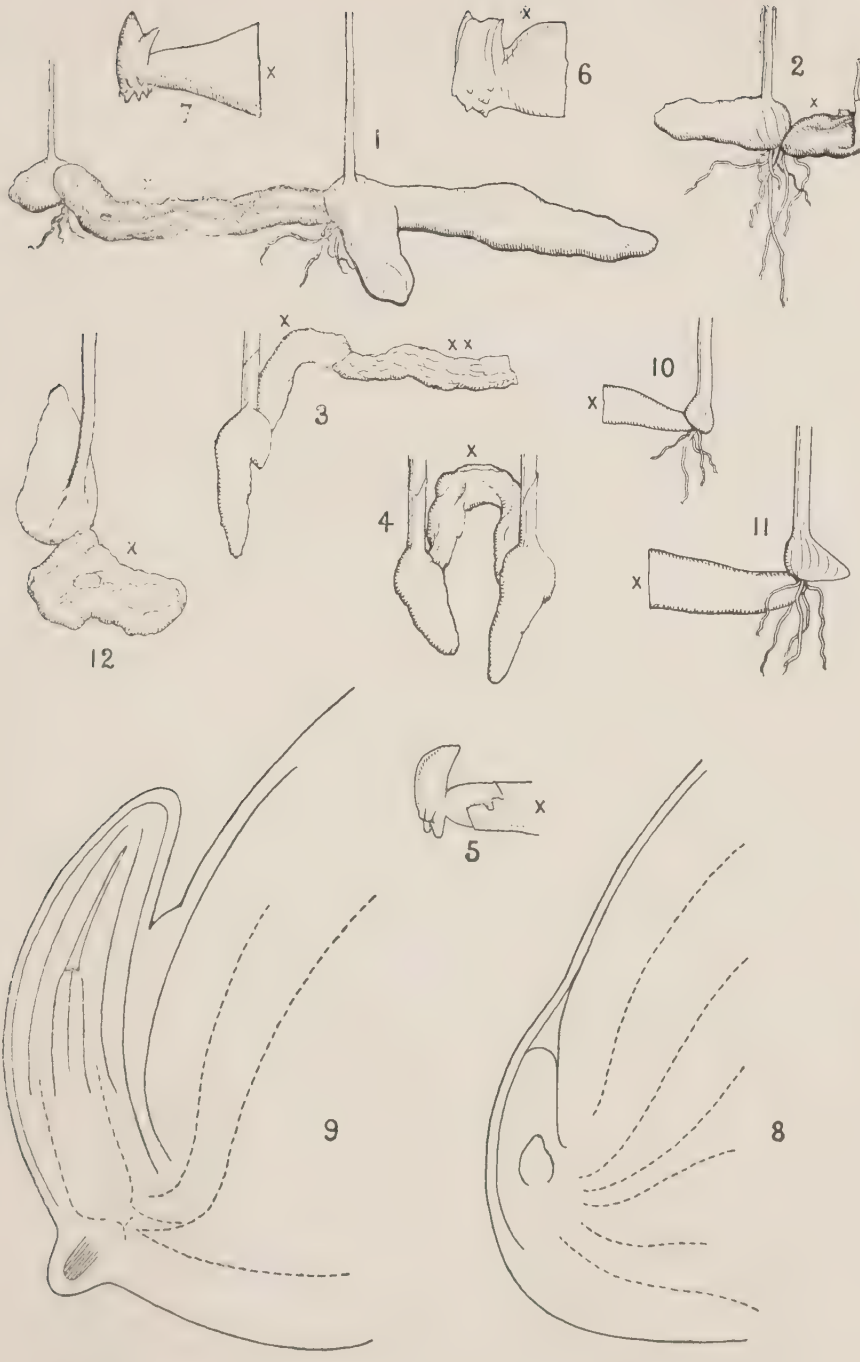
Fig. 8. Section through the apex of a corm, showing the developing bud scale ; x 20.

Fig. 9. Ditto ; an older stage ; x 20.

Fig. 10. Apex of old corm, and base of stem of the young plant ; nat. size.

Fig. 11. Apex of old corm, and base of stem of the young plant, showing development of the long arm of the new corm ; nat. size.

Fig. 12. New corm directed upwards, because the old corm was planted too deep ; nat. size.



Block by Survey Dept. Ceylon

THE CORM OF GLORIOSA SUPERBA

Notes on Ceylon Thelephoraceae, etc.

BY

T. Petch, B.A., B.Sc.

STEREUM

Among the fungi sent from Ceylon by Gardner, Berkeley recorded **Stereum nitidulum** Berk., a species which he had previously described from Brazil. The specimens were accompanied by a painting which is now in the Kew Library.

In the Fungi of Ceylon, No. 586, Berkeley and Broome again recorded this species, without any collection number, and added the note, " a large form possibly distinct ; more fasciculate in its mode of growth, more divided, and marked with little raised lines. The normal form was collected in Ceylon by Gardner. " These specimens were Thwaites 62. The painting of Thwaites 62, however, was labelled *Stereum elegans*, and on it there is a reference to Jour. Linn. Soc., XV, p. 388, No. 300, *i.e.*, to the record of *Stereum elegans* in Berkeley and Cooke's Fungi of Brazil, though there is no mention there of the Ceylon fungus. Berkeley labelled the specimens, " *Stereum nitidulum* B. *forma major*. *Stereum elegans* var. " One of the specimens from Thwaites 62, *ex* Herb. Currey, is included under *Stereum elegans* in Herb. Kew. The painting shows two groups of pilei, which differ in colour.

Lloyd, Synopsis of the Stipitate Stereums (1913), states that the specimens from Ceylon referred by Berkeley to *Stereum nitidulum* should be assigned to *Stereum elegans*, but it is not clear to which collection his statement refers. The Kew sheet, Thwaites 62, bears a note by Bresadola, " a Stereo nitidulo typo certe specifice diversum, nec var. imo nec omnia specimina identica sed duas sistunt formas scilicet a e unam, f—h aliam. "

A point which adds considerably to the difficulty of determining these cartilaginous species of *Stereum* does not appear to have been generally recognised. It is that the hymenium develops late, and the fungus may attain its full stature before the hymenium is formed. Consequently, herbarium specimens are very liable to be deficient as regards cystidia, etc. The development of the hymenium in *Stereum elegans* and allied species would appear to require investigation.

The specimens, Thwaites 62, marked f—h by Bresadola in Herb. Kew, are the common form attributed to **Stereum elegans** in Ceylon. This grows in rosettes, up to 15 cm. diameter, often concentrically, the individual pilei being infundibuliform, flabelliform, or spathulate, separately stalked but concrescent above. Its colour is unattractive, being pallid, or pale brownish white, with obscure, deeper brown, concentric zones. When dry it is usually almost black, not zoned, glabrous, and finely radially ridged, but young specimens may dry deep red brown. The stalk when fresh is pallid, or pale yellow, or ochraceous, and minutely tomentose ; when dry it is densely covered with short, erect, rufous tomentum, or has a paler brown, or almost white, felted covering, according to the age of the specimen when gathered. This tomentum extends up to the base of the pileus. The spores are white, subglobose, 3-4 μ diameter. The hymenium contains scanty cystidia, rough, narrow flask-shaped or fusoid, 30 μ high, 6 μ diameter, which do not project.

The above form grows on the ground, but that statement is misleading without further explanation. It usually grows on the ground, in the neighbourhood of half-buried wood. In one occurrence, it appeared in nursery beds which had been bordered by planks, half-buried on edge, to retain the beds in shape. The rosettes of the fungus sprang up on the soil, but close to the wood, the mycelium evidently originating from the latter.

The second form, marked by Bresadola *a-e*, has much the same habit, but the pilei are usually in smaller clusters. Individually they are larger, more flabelliform and lobed, and sometimes infundibuliform. The colour when fresh is brighter, pale yellow to ochraceous, with distinct, yellow-brown to purple-brown, concentric zones. In drying it becomes deep red brown, but usually retains its zonation. The surface is rather more coarsely ridged than in the previous form when dry, and it is generally, but apparently not always, minutely scabrid with short, brown, scattered hairs. The stalk, in the dry specimens, is densely covered with short, rufous tomentum, and when growing on wood it has a distinct, matted, strigose, rufous pad at the base. Cystidia have not been found in this form.

The habitat of this second form varies. Thwaites' specimens appear to have grown on the ground. A recent collection from Anuradhapura, with identical pilei, certainly grew on wood, and they have a well-developed pad at the base of the stem. Another collection was brought to me with the information that the specimens grew on a jak log : the stalks are exactly like those of Thwaites' specimens, and they evidently grew at the junction of the log and the soil.

It would seem probable that this second form is **Stereum surinamense** Lèv. though the latter is said to be smooth and to lack the basal mycelial pad.

Consequently, *Stereum nitidulum* Berk. must be deleted from the Ceylon list as far as regards Thwaites 62. The specimens sent by Gardner, and referred to *Stereum nitidulum* by Berkeley in Decades of Fungi, after No. 183, are, however, not the same species as Thwaites 62. I have specimens from the low-country which exactly match Gardner's figures and these are not *Stereum elegans*. They grew on dead wood, and when fresh were ivory white, slightly translucent. After drying they are bay, with concentric darker zones. Gardner's figures show an intermediate stage of drying. The specimens are about 1 cm., high, 8 mm. diameter, stalked, infundibuliform or obliquely infundibuliform, glabrous, and cartilaginous. The stalk is stout, and arises from a circular, fleshy, basal disc, up to 6 mm. diameter, which appeared glabrous when fresh, but is minutely pruinose when dry. Erect processes arise from the base of the funnel, as in *Stereum hydrophorum*, but in these examples they do not extend to the level of the rim.

Another collection, from Peradeniya, consists of similar specimens, but different in colour, red brown with darker concentric zones. These also grew on wood. They are regularly infundibuliform, up to 1.5 cm. high, 2 cm. diameter, with a stout base, or short stalk, either terete, 5 mm. diameter, or laterally compressed, up to 8 mm. broad and 3 mm. thick. When fresh the stalk was yellow ; it arises from a broad basal disc, up to 1 cm. diameter, glabrous when fresh, minutely pruinose when dry. The specimens were cartilaginous when fresh, and adjacent examples have coalesced laterally ; dry, they are horny, but the rather thick tissue at the base of the funnel is white and corky internally. In each specimen, the funnel is filled with erect forked processes, which form a rosette arising above the rim. In one example, the outer half the pileus is decurved, and this has a rosette of processes in the funnel, and tufts of similar processes in a circle on the decurved part.

These specimens are evidently an abnormality similar to that which occurs in *Stereum hydrophorum* ; but it is not the latter species as the pileus is glabrous. The specimens represented by Gardner's figures are apparently normal. All the available examples appear to be immature, and no larger specimens have been collected to which these might be referred. They differ from *Stereum Mellisii* in texture, and in the basal disc, which is not fibrillose ; while the latter feature and the stout stalk distinguish them from *Stereum surinamense*. When fresh, they bear a marked resemblance to *Polystictus xanthopus*. I would place them under **Stereum curtum** Fr., which was described as having a circular, dilated

base, adnate to the wood, as in these examples. Lloyd (*op. cit.*) states that *Stereum curtum* appears to consist of small depauperate specimens of *Stereum surinamense*.

Thwaites 682 was assigned to *Stereum elegans* by Berkeley and Broome in Fungi of Ceylon, No. 587. Lloyd (*op. cit.*) refers these to *Stereum surinamense*. But the corresponding specimens in Herb. Peradeniya have a thick, brown, circular, strigose pad, up to 1 cm. diameter, at the base of the stem, and rough, hyaline, conical or cylindric cystidia, 24-36 μ high, 8 μ diameter, which project about 16 μ above the hymenium. Hence these would appear to be **Stereum Mellisii** Berk., not *Stereum surinamense*.

Stereum floriforme Bres. has been collected at Peradeniya on two occasions. In one collection the pilei are for the most part regularly reniform, as in *Stereum affine* Lév.; these specimens grew on wood. In the other collection they are more variable ; some of the examples of the latter grew on the soil at the base of a stump and others on the stump to a height of eight inches from the ground.

Stereum malabarense Cke. (det. Lloyd) has been gathered at Kalupahani (No. 4426, April 1912).

Stereum partitum B. & Br., Fungi of Ceylon, No. 588, is referred by Lloyd to *Stereum glabrum* Lév.

Stereum tuba B. & Br., *fide* Lloyd, is a *Cyphella, Cyphella tuba* (B. & Br.) Lloyd.

Stereum pusillum Berk. was described by Berkeley from a specimen in Herb. British Museum which had been collected in Ceylon by König, and consequently in the Trincomalie—Batticaloa district. Lloyd states (*op. cit.*) that as to habit and colour it is the same as *Stereum nitidulum* and *Stereum Ravenelii*, and very close to the latter.

Stereum lobatum Fr. The hymenium of this species is usually red or brownish red when wet. The spores are white, narrow-oval, 4-6 x 2.5 μ. Burt (Ann. Missouri Bot. Gard., VII. p. 155) refers *Stereum ostrea* (Bl. & Nees) to *Stereum fasciatum* Schw., and holds that the common tropical *Stereum lobatum* is distinct. Our Ceylon species is certainly *Stereum ostrea*, as figured in the original publication. In the Ceylon species, the umbo is the part of the fungus first formed. If it is growing on a subvertical surface, the upper edge develops into the flabelliform pileus while the lower edge may remain small or may grow over the substratum as a resupinate lower half. If the fungus grows on the lower surface of a branch, the pileus may be distinctly centrally stalked and broadly concave or infundibuliform. Adjacent pilei fuse, and form long lines of concrescent cups, or a long narrow pileus divided at the base. Burt states, with regard to *Stereum fasciatum*, that " the fructifications are

at first effuso-reflexed with the resupinate portion up to one centimetre broad, the reflexed portion 1½ cm. from base to margin, and with a lateral extent along the substratum of 2-8 cms.; umbos soon form at points 1-2 cm. apart along the line of intersection of the plane of the reflexed portion with the substratum." The development of the Ceylon species is the reverse of this ; the pilei are not attached except at the umbo.

Stereum perlatum Berk. Specimens, No. 3637, Dec. 1912, exactly match McGregor, Bureau of Science, No. 10553, det. Bresadola as this species. The upper surface is tomentose at first, with short grey tomentum, becoming glabrous when old. It has the habit of *Stereum lobatum*, but is thinner, concentrically and radially ridged, deep purple brown, almost black behind.

Stereum percome B. & Br. The old herbarium specimens of this species (Thwaites 983) have the hymenial surface bright yellow-brown, and the zoned, strongly strigose, upper surface pale brownish grey. The thickness of the free edge is about 0.2 mm., excluding the strigose layer, and the context appears dark brown in section, macroscopically. By transmitted light, however, only the hymenial layer and the tissue immediately beneath it is dark brown, the remainder being pale yellow. The "hymenium" consists of rough, yellow hairs, 5 μ diameter, slightly inflated at the tip, arranged in a loose palisade layer. Basidia have not been seen.

In recent specimens the colour is variable. In one collection, the hymenium is yellow-brown, with a narrow lavender edge : in another, it is rufous brown, bordered by a narrow purple-brown zone and a lavender edge.

Bresadola (Ann. Myc., XIV, p. 232) refers this species to *Lloydella papyracea* (Jungh.) Bres. The latter, *Stereum papyraceum* Jungh., is described in Saccardo as "livido-expallens ; pileo margine libero undulato-zonato, glabriusculo, hymenio sub lente velutino." The colour of the Ceylon specimens is different, they are strongly radially strigose, and there are no projecting setae on the hymenium. Apparently all the available Ceylon specimens are immature. The hymenial surface consists of rather distant hairs, all attaining the same level, and it is doubtful whether these can be regarded as cystidia or gloeocystidia.

Stereum papyrinum Mont. This was recorded for Ceylon by Berkeley and Broome from Thwaites 220, 740, 257, 536 and 544. In Grevillea, VIII, p. 20 (1879), Cooke transferred *Stereum papyrinum* Mont. to *Peniophora*, citing as localities, "Australia, Ceylon, Brazil, etc." Cooke's figure of the cystidia shows them rough. Massee accepted Cooke's reference, and cited a specimen from Montagne in Herb. Berk.

In Ann. Myc., IX, p. 271 (1911), Bresadola transferred *Stereum papyrinum* Mont. to *Lloydella*, as *Lloydella membranacea* (Fr.) Bres.,

stating that the cystidia were smooth. The latter statement is directly opposed to Cooke's and Massee's, to Cooke's figure, and to the Ceylon specimens, and if correct the Ceylon specimens are not *Stereum papyrinum* Mont. Consequently, Cooke's name will be retained for them.

Thwaites 740 is apparently *Peniophora papyrina* Cke. as described by Massee. Thwaites 257 was given by Berkeley and Broome as *Trametes lobata*, *Stereum papyrinum*, and *Psilonia gilva*; it is *Psilonia gilva* in Herb. Peradeniya, and *Trametes cervinogilvus* in Herb. British Museum. Thwaites 536 in Herb. Peradeniya is a *Peniophora*, on charred wood, and is identical with *Corticium lilacinum* B. & Br. which was described from Thwaites 997, also on charred wood. Thwaites 544 was stated by Berkeley and Broome (*sub* Fungi of Ceylon, No. 585) to be an imperfect state of *Thelephora accumbens* or some allied species, and it is included in the cover of *Thelephora accumbens* in Herb. Kew; it is not *Peniophora papyrina*. Thwaites 220 is *Corticium* (*Duportella*) *tristiculum*.

Cooke's figure and measurement (35 x 12 μ) of the cystidia may have been taken from Thwaites 740, though the breadth is too large. Massee's measurement (80 x 12 μ) is nearer that of Thwaites 536.

Stereum notatum B. & Br. Berkeley and Broome described this species as "effusum, margine tomentoso pallido libero; hymenio hic illic concentrice notato pallido": and added the note, "spreading for several inches. At first looking like a little *Cyphella*; but the individuals soon become confluent; hymenium marked with concentric rings; edge thin papyraceous." Massee stated that, judging from the stains on the dried specimens, it gave out a red juice when bruised.

The specimen of *Stereum notatum* in Herb. Peradeniya includes a resupinate piece measuring 10 cm. x 4.5 cm., marked here and there with concentric ridges. It is evidently composed of several individual pilei united laterally, each series of concentric ridges denoting a separate pileus. Apparently it grew on the lower surface of a log, so that it is almost entirely resupinate, becoming free towards the margin. Recent collections are circular, only centrally attached, sometimes dorsally attached towards one edge, flabelliform and lobed. When dry it is rigid and somewhat horny, the total thickness being about 0.35 mm. The dorsal surface is strongly radially strigose with coarse, white or brownish white fascicles, and marked with narrow concentric zones. The hymenium is greyish brown to purple grey, turning deep red when bruised. The hyphae on the dorsal surface are thick-walled, regular, flexuose, hyaline or yellowish, 2-3 μ diameter. In section, the dorsal surface is yellow and composed of agglutinated yellow-brown hyphae, similar to the free hyphae; the context is pale yellow to hyaline; the hymenial layer is translucent, and contains numerous, dark brown, latex tubes, which run

sub-horizontally in the context, and curve upwards into the hymenium, where they are about 7 μ diameter. In some specimens, and in the type, the contents of these tubes are dark brown, but in young specimens they may be yellow-brown or hyaline. In general appearance, this species bears a considerable resemblance to *Stereum rimosum*, but it is thinner than that species and differs in colour and in the character of the dorsal tomentum.

Stereum rimosum Berk. Specimens matching those from Ceylon assigned to this species by Berkeley and Broome have been collected recently at Hakgala and Peradeniya. When fresh the hymenium is orange yellow, becoming crimson when bruised ; it is usually concentrically ridged and sometimes tuberculate, and cracks on drying. The pilei are generally circular, umbonato-sessile, centrally attached, frequently adherent to the substratum elsewhere by the tomentum of the dorsal surface. The herbarium specimens are up to 1·5 mm. thick in the centre, the recent specimens only about 1 mm. thick. The dorsal surface is spongy tomentose, sometimes radially strigose towards the margin, and zoned with brown or yellow-brown beneath the tomentum. The fungus appears waxy when fresh, but in drying becomes rigid or coriaceous, and if allowed to dry without pressure, generally cup-shaped. The hymenium includes gloeocystidia which contain irregular yellow granules.

Stereum Lepra B. & Br. Massee transferred this to *Corticium* (Mon. Theleph., p. 130). It has been redescribed as *Aleurodiscus Lepra* (B. & Br.) v. H. and Litsch., in Sitzungsber. d. k. Akad. d. Wissensch. Wien, Mathem.-naturw. Klasse, Bd. CXVII, p. 1098 (Oct. 1908).

Stereum sparsum Berk. This has been recorded in Saccardo for Ceylon and Australia. The Ceylon record is an error, due to confusion with *Corticium sparsum* B. & Br., which is a *Peniophora* and was transferred to *Peniophora* by Cooke in Grevillea, VIII, p. 21.

Berkeley and Broome described, in the Fungi of Ceylon, three species of *Stereum*, *viz.*, *Stereum albocinctum*, *S. endoleucum*, and *S. duriusculum*, which have since been the subject of considerable difference of opinion. Massee, Mon. Thelephoreae, referred all these to one species, citing " auriusculum " in error, and included with them, *Stereum annosum* B. & Br., another Ceylon species, stating that the spores were 4 x 3 μ. Bresadola, in Ann. Myc., XIV, p. 232, stated that *Stereum duriusculum* was the same as *Stereum albocinctum* ; in his notes on the sheets in the Kew Herbarium he wrote, " *Stereum duriusculum* est la même espèce " on the sheet of *Stereum albocinctum* : " *Stereum duriusculum* B. & Br., *Stereum induratum* Berk. type, et *Corticium portentosum* B. & C. sont pour moi tres

formes d'une même espèce," on the sheet of *Stereum duriusculum* ; and "mihi valde dubia species, certe non *Stereum*," on the sheet of *Stereum endoleucum*.

In Bull. Soc. Myc. France, XXXVI, p. 75, Bourdot and Maire recorded the result of their examination of the type of *Stereum duriusculum*. They stated that the type was sterile. It formed a plate, scarcely 1 mm. thick, rigid and fragile : the context was wood-colour to pale fawn, the surface pale clay-coloured. The ultimate branches of the hyphae were elongated, almost flagelliform and rather hyaline, so that the fungus appeared to be near *Corticium portentosum* (American specimens). Bourdot and Maire stated that *Stereum duriusculum* and *S. albocinctum* belong to a group of species characterised by much branched, dendroid hyphae, which ought to be included in the genus *Asterostromella* ; they would not modify the conception of that genus except to extend it to substratified species, with a coloured context, and with spores frequently spherical and rough.

Stereum albocinctum B. & Br. The type specimens (Thwaites 661) are now pale brownish white. They may have been white or cream-coloured when fresh. Berkeley and Broome described them as isabelline and also as a delicate fawn colour. They are irregularly oval or lobed, a few centimetres long and broad, undulating, entirely adnate, with a rounded or sub-vertical margin which is either of the same colour as the remainder of the surface, or chalky white, or, on the thicker pieces, white above and pale brown below. The thickness varies from 1·5 to 3 mm. Internally the fungus is cinnamon brown, somewhat obscurely stratose, rather friable and soft, easily cut but tending to break up. The internal zones, as seen in section, are narrow, about 120 μ broad, but they separate horizontally in thicker layers, about 0·5 mm. thick. The hyphae in each zone are irregularly interwoven below, becoming more or less parallel and vertical above, the direction of the hyphae in general being vertical. They are brownish yellow, and not fused, or only slightly fused, into a continuous mass. The larger hyphae are 2—3 μ diameter, thick-walled, rigid, and branch at a wide, rounded angle, so that they have the appearance of an old oak tree. These give rise to finer hyphae, 1—1·5 μ diameter, which fork and branch repeatedly, giving off short spine-like branches. These finer hyphae become solid. Entangled among these hyphae are oval,yellow-brown, spinulose spores, 6 x 4 μ. The surface is minutely tomentose with fine, branching, hyaline hyphae, 1·5 μ diameter. and a few, projecting, yellow-brown hyphae, 2 μ diameter. Basidia have not been seen.

Stereum endoleucum B. & Br. was Thwaites 996, not 966 as given in the Fungi of Ceylon. The specimens are apparently on a palm stem.

They are resupinate, greyish white, sometimes with a paler margin, the margin being tomentose or substrigose, rounded, sometimes free and slightly recurved. The total thickness is about 1·5 mm., and the context is rather soft, crumbling when cut, not stratose, but feebly vertically ridged on fracture. The specimens are fragile and transversely cracked. The internal colour is now the same as that of the upper surface: Berkeley and Broome stated that the hymenium was "ochroleucum," and the context "niveum." The hyphae are hyaline, stout, irregular, thick-walled, up to 6 μ diameter, with a lumen reduced to 1.5 μ diameter, or sometimes solid. On staining with cotton blue, only the contents of the hyphae stain. Most of the hyphae, however, are empty, and consequently the blue stained lines, only 1—1·5 μ broad and widely separated from one another, appear at first sight to be another fungus permeating the *Stereum*. The hyphae are loosely coherent and run more or less vertically. At the surface they form a more compact, narrow, palisade layer, with a few projecting hyphae. Basidia have not been observed.

For **Stereum duriusculum,** Berkeley and Broome cited Thwaites 329, 560. The specimens are 329, 569. The fungus when fresh is cream-coloured. Berkeley and Broome stated that it was ochraceous, and the specimens are now somewhat brownish ochraceous. They are effused, up to 1·5 mm. thick, internally brownish white, or very pale brown, and markedly stratose. The context is firmer than in *Stereum albocinctum*, and it does not cut so easily. In section by transmitted light, the context is zoned with alternate hyaline and pale yellow zones. The hyphae are 2—3 μ diameter, irregular, some solid, others thick-walled, giving off finer branches, long and flexuose, down to 0·75 μ diameter. The tissue is more compact than in *Stereum albocinctum*, and the hyphae differ in colour and mode of branching. In the yellow zones the hyphae are more closely interwoven than in the hyaline zones. It appears that the hyaline part is the lower part of each growth zone, while the yellow part marks its upper limit. The surface is tomentose with projecting hyphae, 1·5 μ diameter, which give rise to very fine hyphae, studded with granules. No basidia have been found. Crystals of calcium oxalate occur in the lower layers of the context.

There can be no doubt that, whether they are Stereums or not, *Stereum albocinctum*, *S. endoleucum*, and *S. duriusculum* are all distinct from one another and distinct from *S. annosum*. What they really are is doubtful, but it would seem probable that they are *Ceriomyces* forms.

Massee, in Mon. Thelephoreae, recorded *Stereum rugosum* Fr. for Ceylon. The specimen in Herb. Kew is Thwaites 993, and it is clearly *Stereum albocinctum* B. & Br. Berkeley and Broome cited Thwaites 993, *inter alia*, for their *Stereum ruberrimum*.

In Fungi of Ceylon, No. 623, Berkeley and Broome recorded **Corticium laeve** Fr., citing Thwaites 329, 331, and 607. These three are different species. Thwaites' sheet marked 329, 369 in Herb. Peradeniya contains specimens of both numbers ; one of these is *Stereum duriusculum*, as in the type of the latter, while the other is a younger growth of the same. The latter forms an effused patch over 10 cm. long and 4.5 cm. wide, and shows the internal yellow zones only in the thicker parts. Thwaites 607 was described by Berkeley and Broome in Fungi of Ceylon, No. 649, as *Corticium ambiens* B. & Br.

Stereum annosum B. & Br. is quite different in appearance and structure from the three species with which Massee included it. The internal colour resembles that of *Fomes applanatus*. The colour of the hyphae is similar to that of the hyphae of *Stereum albocinctum*, but the hyphae are stout, 4 μ diameter, and for the most part regular and normal in character.

Another species, similar to *Stereum duriusculum*, but clearly distinct, has been collected on several occasions at Hakgala. In general, it forms oval or irregular, thick plates, a few centimetres broad, resupinate, becoming undulating and partly free, with a rounded margin. One specimen, however, gathered with the common form, on a branch 1·5 cm. diameter, extends in a continuous layer for 12 cms. along the branch, thinning out laterally without a definite margin. The stroma is white at first, becoming ochraceous when old, and blackish at the base. It is up to 4 mm. thick, very hard, and closely laminated internally, consisting of pallid or pale yellow subtranslucent plates, separated by white chalky zones which vary in width from 20 to 250 μ. The white zones are not regular, but broaden out here and there into pockets. A specimen 4 mm. thick shows twenty or more superposed plates. In section, the plates are hyaline, and the hyphae of which they are composed are fused into a sclerotioid mass. The white lines or pockets between the plates consist of aggregations of irregular granules of calcium oxalate, permeated by a few hyphae. The superficial layer, external to the uppermost sclerotioid layer, is about 20 μ thick, and consists of clavate or narrowly conical hyphae, up to 20 μ high. Some spherical spinulose spores are present on the outer layer but they appear to be intrusive. This species was apparently not collected by Thwaites.

Stereum insulare B. & Br. was described by Berkeley and Broome as "pallide umbrinum." Massee stated that it was dirty ochraceous. It forms circular or elongated patches, 1 cm. diameter, or 2 x 1 cm., brownish grey, pulverulent, cracking on drying, with a definite, but thin, margin, which is at first tomentose but becomes black and glabrous. The total thickness is about 0·15 mm. Internally it is dark brown, the

hyphae being yellow-brown by transmitted light. The hymenium contains, or in these specimens consists of, closely-packed dendrophyses, 3-4 μ diameter, which branch below, the branches expanding at the apex, forking once or twice, and terminating in short, stout processes which bear numerous spines up to 3 μ long. The apices of the dendrophyses are usually hyaline, and in form they resemble a stout *Clavaria*. Basidia have not been seen. The available specimens appear to be practically a palisade layer of paraphyses. If the fungus is really a Basidiomycete, as it appears to be, it should be referred to *Aleurodiscus*.

Thelephora dentosa B. & C. In Fungi of Ceylon, No. 573, Berkeley and Broome recorded *Thelephora dentosa* B. & C., from Thwaites 343, stating that it grew on rotten wood, and added the note " Exactly the Cuban plant." In Berkeley and Curtis, Cuban Fungi, No. 379, Berkeley cited two of Wright's collection numbers for *Thelephora dentosa*, one, No. 507, from his first collection, and the other, No. 238, from his second ; and added that the name applied better to 507, which had been distributed, No. 238 being more like *T. palmata*. *Thelephora dentosa* was said to spread over the surface of rotten wood, leaves, and other vegetable matter, giving off distinct branches which were sometimes dilated in a flabelliform manner above : sometimes the hymenium was formed where the fungus ran over the leaves. The colour of the fungus was ochraceous, rufous brown below, with the hymenium rufous brown.

Burt (Annals Missouri Bot. Gard., I, p. 224) states that the two collections are two different species. He takes No. 507 as *Thelephora dentosa*, and names No. 238, *Thelephora perplexa*. He does not refer to the Ceylon collection.

From Berkeley's description, and Burt's amended account, of the Cuban fungus, it is clear that the Ceylon *Thelephora dentosa* is a different species. The Ceylon specimen is Herb. Kew is marked by Lloyd, "Cited in error in Saccardo as type, not same species."

The Ceylon fungus does not grow on dead wood, etc., and it is not encrusting. It grows on the ground, stalked and erect, more or less in clusters after the fashion of *Stereum elegans*, but not definitely rosetted. Small specimens, up to about 7 mm. high, are spathulate or flabelliform, about 4 mm. diameter above, entire, attenuated below into a short stalk about 1 mm. diameter. Larger specimens are up to 2·5 cm. high, 2 cm. broad above, generally deeply divided into cuneate lobes, the longer divisions reaching almost to the base. Adjacent pilei are concrescent laterally. The fungus is fleshy, not horny, and becomes rigid on drying. When fresh the colour is pallid, or brownish grey, or purple grey, obscurely zoned; when dry, it is brownish grey and pruinose on the dorsal surface, dark purple grey below. The dorsal surface is sometimes radially ridged.

The pileus is stout, about 0·5 mm. thick, fibrous internally and pale yellow in mounted sections. Cystidia are absent, and the fungus does not turn red when bruised. Spores have not been observed.

This species is a *Stereum*. It differs from *Stereum partitum* in its texture and its more divided pilei. In texture it resembles *Stereum Thwaitesii* (*Cladoderris Thwaitesii* B. & Br.), but it differs from that species in not changing colour when bruised. It may be known as *Stereum divisum*.

Stereum divisum Petch, n. sp. Pilei stalked, spathulate or flabelliform, plane, up to 2·5 cm. high, 2 cm. broad above, repeatedly divided into cuneate lobes, the longer divisions extending almost to the base, thick, fleshy when fresh, rigid when dry; pallid, brownish grey or purple grey when fresh, obscurely zoned; when dry, brownish grey and pruinose above, dark purple grey below; dorsal surface sometimes radially ridged; context fibrillose; cystidia absent. On the ground, often in clusters, adjacent pilei laterally concrescent. No. 6099, Dewalakande, August 1919.

Stereum tenerum Petch, n. sp. Dimidiate; pilei orbicular, upper surface white, hymenium pale violet, becoming ochraceous when old, up to 2 cm. long, 1 cm. broad, arising from a continuous resupinate patch; thin, total thickness about 0·6 mm., tender, upper surface silky tomentose, hymenium concentrically undulating. Dorsal layer spongy, about 0·4 mm. thick, of decumbent, hyaline to yellow-brown, thick-walled hyphae, 2 μ diameter, united into coarse, yellow, flexuose strands, 16 μ diameter, which give off numerous free, hyaline hyphae; dorsal hyphae fused below into a continuous, yellow-brown, subtranslucent layer, 0·1 mm. thick; context hyaline, loose, 0·1 mm. thick; hymenial layer 30 μ thick, without cystidia or gloeocystidia.

Hakgala, April 1924: No. 4063. The colours of the fresh specimens are those of *Polystictus elongatus*. When dry, the hymenium becomes greyish brown, and preserved herbarium specimens are red-brown.

Stereum ruberrimum B. & Br. For this species Berkeley and Broome cited Thwaites 323, 462, and 993. No. 993 was included in Herb. Berkeley as *Stereum rugosum* Fr., and it is actually *Stereum albocinctum* B. & Br. The description of *Stereum ruberrimum* is "Pulvinatum; hymenio pulchre rubro in basi nigra insidente; margine angustissimo albo. On lichens and their apothecia." Massee included it in *Stereum* in his Monograph of the Thelephoreae, adding that the spores were ellipsoid, 6 x 4 μ.

In Thwaites 462, the red colour is confined to the lichen fructification. The disc is rather dark purple red, with occasionally a slight reddish coloration on the surrounding thallus. In section, the colour is found to extend to the base of the apothecium, varying from purple red to

red brown. It is due chiefly to minute, red spherical globules, up to 4 μ diameter, which encrust the paraphyses. The mature ascospores are slightly tinged brown, but the immature spores may be red brown, in the herbarium specimens. The latter effect is probably due to preservation with alcoholic mercuric chloride, as the colouring matter is soluble to some extent in alcohol. This specimen does not agree with Berkeley and Broome's description. There is no pulvinate stroma, the margin is not white, and there is no black base except the wall of the apothecium. The whole of the tissue is apparently that of the lichen, and there is no *Stereum* present. The specimen is a lichen with the disc of the apothecium purple red.

The other specimen, Thwaites 323, is on a lichen, which has not developed fructifications. The supposed *Stereum* is vermilion. In some places, it consists of a thin, diffuse, discontinuous, powdery patch, which sometimes borders a crack in the lichen thallus. Elsewhere are definite, more or less circular, irregularly tuberculate, powdery, vermilion patches, up to 5 mm. diameter, sometimes with a narrow, black margin. They are not, in the specimens examined, seated on a black stroma, the latter being merely marginal. The irregularity of the red stroma is due to irregularities in the substratum. In section the stroma is 80—100 μ thick, purple red by transmitted light. Underlying the red part there may be a hyaline tissue up to 110 μ thick, but this apparently occurs only in hollows of the substratum. The purple red layer consists of loosely intertwined, hyaline hyphae, about 1 μ diameter, densely encrusted with irregularly angular, purple red granules, which sometimes form masses up to 12 x 8 μ. These granules are not affected by hydrochloric acid. The hyaline basal tissue consists of similar hyphae, loosely interwoven, among which are embedded large numbers of crystals of calcium oxalate. The colouring matter is slightly soluble in alcohol, but is not altered by lactic acid or hydrochloric acid. There is no indication that this specimen is a *Stereum*, and it would seem probable that it is a state, perhaps abnormal, of the lichen.

Stereum acerinum Fr. As stated in Ann. Perad., VI, p. 157, the Ceylon specimens attributed to this species in Fungi of Ceylon, No. 603, are not a fungus.

Stereum sulphureum Fr. The specimens recorded under this name in Fungi of Ceylon, No. 602, are identical with *Corticium flavo-rubens* B. & Br. They are also the basis of Massee's record of *Stereum strumosum* Fr. for Ceylon (see Ann. Perad., VI. p. 156).

HYMENOCHAETE

Hymenochaete subpurpurascens (B. & Br.) Massee. This was described by Berkeley and Broome as *Stereum subpurpurascens*, in Fungi

of Ceylon, No. 598. It was transferred to *Hymenochaete* by Massee, Mon. Theleph., p. 101. The pileus is dimidiate, or circular and centrally attached, closely concentrically sulcate above, minutely radially strigose, becoming almost glabrous, rigid, up to 1·5 mm. thick, dark purple-brown. The lower surface is purple-brown, smooth, without evident setae. The context is fibrillose, sudan brown to amber brown, with a thin, black, solid, dorsal layer underlying the tomentum ; the hymenium is purple-brown, darker than the context. In section the hymenium is stratose ; it is composed of crowded fusoid setae, 4-8 μ diameter, slightly encrusted, with a subacute apex, not, or barely, projecting. In recent specimens, the hymenium is olive-brown, with a bright red-brown margin ; these specimens are thinner than the type, the hymenium is not stratose, and the setae project up to 24 μ. Specimens, No. 523, E. B. Copeland, Flora of the Philippines, stated to be determined by Bresadola as *Hymenochaete cacao* Berk., appear to agree with the thinner form of *Hymenochaete subpurpurascens*.

Hymenochaete rigidula B. & C. This was originally described by Berkeley from Cuba. It has been re-described by Burt, who states that the upper surface is snuff-brown, and the hymenium benzo-brown, with an ochraceous tawny margin. The Ceylon specimens named by Berkeley and Broome are entirely resupinate ; the dorsal surface is near antique brown but brighter, rather strongly matted tomentose, with the tomentum inclined to be massed in small cushions ; the hymenium is Prout's brown, with a yellow ochre margin ; the setae are somewhat crowded, conical, acute, 30-50 μ long, 6-8 μ diameter, projecting 16-30 μ; the fungus is about 1 mm. thick, and a thin, black, dense, dorsal layer underlies the tomentum.

Specimens, which appear to be identical with Thwaites's collection, have been gathered recently, in all cases on very decayed stumps. They consist of masses of imbricated pilei, the resupinate part being small and irregular, probably because of the nature of the substratum. The tomentum of the dorsal surface is well-developed. The free margins are up to 2 cm. broad, closely concentrically sulcate, with minutely tomentose, Argus brown zones, alternating with glabrous, black lines. The hymenium is slightly darker than in the Thwaites specimen, and the margin is antique brown.

It would seem probable that the Ceylon species is not the same as that from Cuba.

Hymenochaete tenuissima (Berk.). This was described by Berkeley from Ceylon specimens as *Stereum tenuissimum* in Decades of Fungi, No. 184 (1847). In Jour. Linn. Soc., X (1868), p. 333, Berkeley and Curtis recorded *Hymenochaete tenuissima* Berk. from Cuba, with a re-

ference to the Ceylon fungus ; the Cuban specimen, however, has since been found to be a different species. In Fungi of Ceylon, No. 607 (1873), Berkeley and Broome recorded the Ceylon fungus again, as *Hymenochaete tenuissima* Berk. (*Stereum tenuissimum*, Hook. London Jour., 1847, p. 510), from Thwaites 10 and 534. Bresadola, in Ann. Myc., XIV, p. 233, states that *Hymenochaete tenuissima* is identical with *Hymenochaete rheicolor* Mont., and he has attached a note to that effect to the Ceylon specimen in Herb. Kew which was collected by Thwaites in 1850.

In Herb. Kew, there are, in the cover of *Hymenochaete tenuissima*, the type specimen collected by Gardner on the Horton Plains in February 1846 ; specimens collected by Thwaites in 1850, 1851, and 1854 ; Thwaites 10 and 534 ; and a Thwaites specimen without a number.

In Fungi of Ceylon, No. 609, Berkeley and Broome recorded **Hymenochaete crocata** Lév., collected by Thwaites in 1850. This Ceylon specimen in Herb. Kew is the thicker form of *Hymenochaete tenuissima*.

Hymenochaete leonina B. & C. was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 614, from Thwaites 335. In the cover of *Hymenochaete leonina* in Herb. Kew, there is a piece of Thwaites 335 which is marked *tenuissima* by Berkeley, another piece which is also *tenuissima*, and a third piece which is *Hymenochaete barbata* Massee. Massee removed two pieces of this Thwaites number to the cover of his new species, but apparently overlooked this third piece.

Hymenochaete spadicea was described from Thwaites 534 in part. The specimens were apparently imperfectly separated, and the type of *Hymenochaete spadicea* contains both that species and *Hymenochaete tenuissima*.

Hymenochaete rheicolor Mont. (*Hymenochaete tenuissima* Berk.) is common in up-country jungles in Ceylon. It usually grows on small dead branches, producing orbicular pilei, centrally attached, which increase until they fuse laterally and form a continuous stroma, often extending for several feet along the branch, with a free lobed margin, up to three or four centimetres wide, on either side. The resupinate part is usually separable from the substratum. Sometimes it spreads along the branch in a continuous sheet, and produces flabelliform pilei at the margin. When growing on larger fallen branches, the resupinate part may be 10 cm. or more broad, and pilei may arise by secondary growth on these patches. On vertical surfaces, imbricated flabelliform pilei are produced, usually in small groups, only slightly decurrent behind. It may spread from the branches to dead leaves, etc., on the ground.

The colour of the pileus is at first gilvous, or raw sienna, becoming antique brown, and finally Argus brown. The hymenium is raw sienna or yellow ochre at first, becoming cinnamon brown and finally Prout's

brown. Large resupinate patches may show a secondary growth, yellow ochre in colour, here and there over the old hymenium. The setae are clearly visible with a hand lens.

The dorsal surface is concentrically sulcate usually radially strigose, sometimes matted strigose without definite radial fascicles. In general the pileus is thin and papery, the total thickness, without the strigose layer, being 0·1—0·15 mm.; the context is composed of hyphae more or less parallel to the hymenium and merges into the strigose layer without any definite zone of separation. In some gatherings, however, the pileus is more rigid, and inclined to crack when bent; in these the hyphae of the context form a denser tissue, about 0·25 mm. thick, with a narrow dense layer, about 20 μ thick, running beneath the hymenium, but discontinuous. The specimen attributed by Berkeley to *Hymenochaete crocata* is this thicker form.

Where the resupinate part shows superposed secondary growth, the latter consists of interwoven hyphae, not parallel to the surface, with narrow, dense, dark brown zones at different levels.

The setae are 56-80 μ long, 8-10 μ diameter, dark red brown, conical, acute, with a narrow central cavity extending nearly all, or part of, the length, and project 40-64 μ. On the secondary thickenings of the resupinate part, they may be 100 μ long.

Hymenochaete nigricans (Lév.) Bres. In Fungi of Ceylon, No. 610, Berkeley and Broome described *Hymenochaete strigosa* from Thwaites 977. The type in Herb. Kew is marked by Bresadola, " = *H. phaea* B. = *H. spadicea* B. & Br. = *H. villosa* (Lév.) Bres." *Hymenochaete spadicea* B. & Br. was described in Fungi of Ceylon No. 612; the type of this in Herb. Kew is marked " = *Hymenochaete villosa* (Lév.) Bres." Massee (Mon. Theleph.) listed *Stereum villosum* Lév. as a *Stereum*, citing a Javan specimen from Léveillé in Herb. Kew, but Miss Wakefield informed me that the specimen is really a *Hymenochaete*. In Kew Bulletin, 1915, p. 368, Miss Wakefield lists *Hymenochaete villosa* (Lév.) Bres., with the synonyms *H. strigosa*, *H. spadicea*, and *H. phaea*, citing Bresadola in Hedwigia, LI (1912), p. 323. In Ann. Myc., XIV (1915), p. 233, however, Bresadola refers all these species to *Hymenochaete nigricans* (Lév.) Bres.

According to Bresadola in Ann. Myc., VIII, p. 588, *Hymenochaete villosa* has setae, 29-45 x 4-7 μ.

The specimen of *Hymenochaete strigosa* in Herb. Peradeniya (Thwaites 977) has the habit of *tenuissima*, with a similar strigose, concentrically sulcate pileus, but its colour on both the upper and lower surface is deep purple-brown, almost black. The thickness of the pileus, omitting the dorsal strigae, is about 0·3 mm. The context is dense, black in section,

deep red brown by transmitted light, and composed of hyphae, more or less parallel to the surface, fused into a solid mass. The hyphae of the strigose layer vary from deep yellow-brown to purple-brown. The setae are conical, 36-56 x 6-8 μ, and project 12-30 μ.

In the type of *Hymenochaete spadicea* in Herb. Kew, the specimens are thinner. One is 0·2 mm. thick, omitting the dorsal strigose layer, deep chestnut brown above, purple-brown below, with the context dense and appearing black in section ; its setae project up to 32 μ. The other, similarly measured, is 0·1—0·15 mm. thick, yellow-brown above, dark-brown below, and does not appear black in section ; its setae are conical, up to 80 x 10 μ, and project up to 50 μ. The first of these is *Hymenochaete nigricans*, the second *Hymenochaete tenuissima*.

In general structure, *Hymenochaete nigricans* closely approaches *Hymenochaete tenuissima*, and it is sometimes difficult to decide whether a specimen is *Hymenochaete nigricans* or old *Hymenochaete tenuissima*. I have specimens of the former in which the thickness of the pileus is only 0·15 mm.

Hymenochaete barbata Massee. This species was described by Massee in Mon. Thelephoreae, p. 109, as " Latissime effusa, adnata, crassa ; margine obtusiusculo ; hymenio laete ferrugineo, ambitu pallescente ; setis conico-acuminatis, 80-140 x 12-17 μ ; sporae ellipsoideae, 4 x 2-2.5 μ." It was part of Thwaites 335, which was assigned to *Hymenochaete leonina* by Berkeley and Broome. Thwaites 335 was a mixture and contained *Hymenochaete tenuissima*, as well as the species described by Massee.

The specimens are totally resupinate, rufous brown, appearing blackish-brown owing to the large setae, tawny at the margin, which is slightly tumid. The thickness of the fructification varies from 0·25 to 0·6 mm., the thicker parts usually exhibiting two layers in the context. The context is composed of interwoven yellow-brown hyphae, with a dense red-brown basal layer of agglutinated hyphae which are more or less parallel to the substratum. Where the context shows two layers, these are separated by a similar red-brown layer. The surface, between the setae, consists of a palisade layer of yellow hyphae, 2-3 μ diameter, which taper irregularly to the apex. The setae are scattered, deep red-brown, elongated conical, slightly inflated below, with a narrow central cavity. Massee gave the dimensions of the setae as 80-140 x 12-17 μ. They are up to 220 μ long, 17 μ diameter, and project up to 150 μ. Apparently his measurements did not include the embedded part.

As already stated, Thwaites 335 contained this species and *Hymenochaete tenuissima*. The setae of *Hymenochaete barbata* are much longer

than those of *H. tenuissima*, and its structure differs from that of the resupinate parts of the latter.

Hymenochaete corrugata Lév. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 617, from Thwaites 145, in part. The herbarium specimens vary in colour from purple-brown to greyish-brown ; they are cracked into small areolae, and the surface is somewhat nodular. The thickness varies from 50 μ to 200 μ, the thicker parts filling inequalities in the bark of the host, and the fungus merges somewhat indefinitely into the latter, without any differentiated basal layer. The context is composed of interwoven fused hyphae, definite regular hyphae being observable only in the cells of the bark, or where the fungus has filled up a crack. Setae occur at all levels from the base of the fructification, and are conical, or cylindric below becoming conical above, acute, 48-80 x 7-12 μ, exceptionally 32 x 7 μ, projecting 20-40 μ.

Fresh specimens of this species are purple grey with a tawny byssoid margin. On preservation in the herbarium they become brownish grey, with a pale brownish yellow margin. In these, which are on wood, the surface is not cracked.

Hymenochaete depallens B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 616, from Thwaites 145 in part. It has not been collected again. The fungus is resupinate, effused, brownish grey, glabrous between the setae, thinning out to a brownish fawn, byssoid margin. It is 0·2-0·4 mm. thick, with the context loose and spongy, reddish brown, composed of thin-walled yellow-brown hyphae, 4 μ diameter, very loosely interwoven below, becoming somewhat denser above, the continuous superficial layer being about 20 μ thick. When the fungus is broken or cracked, the upper layer recurves or shrinks, and the contrast then between the glabrous pellicle and the fibrillose, red-brown, oblique sides of the fissure is very marked. The setae arise in the denser part of the context, some distance below the superficial layer, and are fusoid, sometimes curved above, 100-175 x 12-14 μ, projecting 50-100 μ.

Hymenochaete fuliginosa Lév. This was recorded for Ceylon by Berkeley from a specimen sent by Gardner (*Stereum fuliginosum* Fr.), and by Berkeley and Broome in Fungi of Ceylon from Thwaites 219.

Thwaites 219 grew on bark. It forms a purple-brown, effused fructification, with a rather broad, tawny brown margin. The thickness varies from 0·15-0·25 mm. It is composed of interwoven yellow-brown hyphae, more or less fused into a solid mass, but with individual hyphae visible here and there. There is no definite basal layer. The setae are situated in a single layer, and are scattered, conical, 36-60 x 6-9 μ, projecting

16-40 μ. This is evidently not the same as *Hymenochaete fuliginosa* (Pers.) Bres., of Burt's Thelephoraceae of North America, nor as *Hymenochaete fuliginosa* Lév., of Wakefield, Kew Bulletin, 1915, p. 368.

The Gardner specimen is quite different from the foregoing. It is resupinate, reddish purple-brown, varying in thickness from 0·15-0·3 mm. at points fairly close together. In the thinner parts, the fructification has a thin, light yellow zone of parallel hyphae overlying the substratum, with a deep red brown layer underlying the setae, and the setae are fasciculate, in groups of up to six. The setae are not branched, but merely arise close together in fascicles, their bases being often irregularly contracted and distorted. In the thicker parts, the context consists of fused interwoven hyphae, yellow-brown, sometimes interrupted by irregular, narrow, red-brown horizontal zones ; the setiferous layer is denser and appears red-brown in thick sections, but there is no definite red-brown layer underlying the setae. The setiferous layer may be stratose. The upper part of the context, immediately below the setiferous layer, contains numerous oval cavities. The setae on the thicker parts are frequently scattered ; they are conical, usually acute, 64-80 x 8 μ, and project up to 30 μ. This species does not appear to have been described. It may be known as *Hymenochaete lictor*. The setae are normal *Hymenochaete* setae, and consequently the fungus does not fall in *Veluticeps* Cooke.

Hymenochaete lictor n. sp. Resupinate, effused, reddish purple-brown, 0·15-0·3 mm. thick ; context of fused interwoven yellow-brown hyphae, sometimes with a zone of parallel hyphae overlying the substratum, sometimes interrupted by narrow red-brown zones, sometimes with a similar zone underlying the steae ; setae in a single layer, conical, usually acute, 64-80 x 8 μ, projecting up to 30 μ, usually grouped in fascicles of up to six.

Hymenochaete floridea B. & Br. This was described from Thwaites 366, which furnished two species, *Thelephora floridea* B. & Br., and *Hymenochaete floridea* B. & Br. The type of *Thelephora floridea* in Herb. Kew is *Hymenochaete*, and all the specimens of Thwaites 366 are the same. This species is fairly common at Hakgala, usually on the trunks of standing trees. It is resupinate, effused, forming purple-red patches extending for several centimetres. Old herbarium specimens are purple-brown. The fructification is up to 0·35 mm. thick, composed of fuscous yellow-brown hyphae, up to 4 μ diameter, more or less parallel to the substratum in the lower part, becoming erect and fused in the setiferous layer. The setae are conical, usually obtuse, sometimes verrucose, 50-72 x 6-8 μ, in a single layer, projecting 15-50 μ.

Hymenochaete pellicula B. & Br. Berkeley and Broome described this in Fungi of Ceylon, No. 990, as "Resupinata, effusa, tenuissima, a matrice hic illic secernibilis, rubiginoso-grisea, margine vix ullo vel tenerrimo." Massee stated that the setae were stout, acuminate, 30-35 x 10 μ, often clear purple by transmitted light, and the spores white, 6 x 4 μ. Massee cited specimens from Ceylon and the United States, but Burt does not mention it in his account of the North American species of *Hymenochaete*.

The type specimen is on bamboo, on which the fungus forms a reddish grey, thin, effused, separable layer. The setae are not evident to the naked eye, and appear as scattered black points under a magnification of forty diameters; they are deep yellow-brown, conical, 24-44 x 6-7 μ. The total thickness of the fructification is about 50 μ, about one-half being yellow-brown. The basal layer is hyaline, and the superficial layer is also hyaline and uneven. The setae do not, or scarcely, project, but are immersed in the irregular, hyaline superficial layer. Here and there it can be seen (in section) that the setae arise from yellow-brown hyphae, 2 μ diameter, but nearly all the yellow-brown layer appears to be disorganised. The basal and the superficial layers are composed of spherical or irregular hyaline cells, about 4 μ diameter, with very fine hyaline hyphae, about 0·5 μ diameter, forming a continuous tissue. The specimen does not appear to be normal.

Massee's statement that the setae are often clear purple may refer to the American specimen. Purple setae have not been found in the Ceylon example. Massee's figure of *Hymenochaete pellicula* does not represent the type.

Hymenochaete semistupposa n. sp. Resupinate, effused, seal-brown, with a broad rufous margin, up to 0·8 mm. thick; vertically fibrillose when broken. Basal layer compact, red-brown (in section), 0·1-0·2 mm. thick, of densely agglutinated hyphae parallel to the substratum; intermediate layer, 0·3-0.4 mm. thick, loose, of dark yellow-brown, somewhat distant hyphae running more or less vertically; upper layer compact, about 0·3 mm. thick, dense, of parallel vertical hyphae, sometimes obscurely stratose. Setae arising at all levels in the upper layer, crowded, fusoid, 40-80 x 6-8 μ, projecting 20-50 μ. On bark of fallen trees, Hakgala; No. 5627, etc., in Herb. Peradeniya.

Hymenochaete crocicreas B. & Br. Berkeley and Broome described this in Fungi of Ceylon, No. 615, as "crassa, resupinata, intus croceo-lateritia, matricem eodem colore tingens. On decayed wood." In Grevillea, VIII, 149, Cooke referred it to his new genus Veluticeps, stating that the hymenium had fascicles of hairs, very short and conical, about 0·05 mm. long. Massee, in his Monograph of the Thelephoreae, stated

that there was no specimen in Herb. Berk., and repeated the original description There is a very small fragment in Herb. Kew now, *ex* Herb. Cooke.

Patouillard (Bull. Soc. Myc. France, XXXI, 77) redescribed this species from specimens from Tonkin. He stated that its real affinities were with the genus *Porogramme* where it should be placed next to *Porogramme lateritia*, and named it *Porogramme crocicreas* (B. & Br.) Pat.

Lloyd (Myco. Notes, VII, p. 1232) records that he receives abundance of *Hymenochaete crocicreas* from Malay and the Philippines. He states that it is not a good *Hymenochaete*, for the setae are not typical of that genus but tend rather towards metuloids ; they are coloured at the base, but hyaline with thickened walls above. Lloyd has examined Cesati's specimen of *Merulius crocicreas*, and finds that the latter is a *Grammothele* : he suggests that the Tonkin specimens are *Merulius crocicreas* Cesati, not *Hymenochaete crocicreas* B. & Br.

Herb. Peradeniya has about 16 sq. cms. of Thwaites 658, the type of *Hymenochaete crocicreas*. The fungus is resupinate, effused, even, reddish grey, hard, cracked (but perhaps in cutting off the specimen). It is up to 1·25 mm. thick, internally deep red, stratose, and somewhat friable. To the naked eye it appears smooth, but when magnified is seen to be covered with minute scattered projections. The hyphae of the context are vertically parallel, 4 μ diameter, orange-red, readily breaking up into short lengths. The older hyphae have solid contents, and the tissue breaks, when cut, like some resinous material. The projections are cylindrical fascicles of hyphae, about 30 μ diameter, rounded above, and projecting about 20 μ above the surface. They are orange-red or red-brown, and consequently are strongly contrasted against the yellow-brown hyphae of the general surface. Except in colour, the hyphae of these fascicles do not differ in any marked degree from the surrounding hyphae of the stroma. It is scarcely possible to regard them as setae or metuloids.

It would appear quite probable that *Hymenochaete crocicreas* and *Merulius crocicreas* are the same species, the projections of the former being the first elements of the pore walls of the latter. A similar development of pore walls from isolated fascicles occurs in *Poria Ravenalae*. Patouillard states that the " emergences " of the Tonkin specimen are sometimes scattered without any definite order, sometimes arranged in lines and confluent and forming minute pores. The hyphae of the stroma of *Hymenochaete crocicreas* are exactly the same as those of the old pore walls of *Poria epimiltina*, and it might be worth while considering whether the former is not a sterile form of the latter.

The type specimen of *Hymenochaete crocicreas* grew on a palm stem, probably coconut. The fungus has not been collected again in Ceylon.

Hymenochaete dendroidea B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 620, from Thwaites 266. It was attributed to " B. & C.", and reference was made to specimens from Venezuela. It was not described with the other Venezuelan fungi in Berkeley and Curtis, Fungi Cubenses, and there is little doubt that, as in other similar instances in the Fungi of Ceylon, the description was drawn up from the Ceylon specimens. It is the well-known and much disputed fungus which grows on the lower surface of *Fomes applanatus*. It is not a *Hymenochaete*. Cooke, in Grevillea, VIII, p. 150, transferred it to *Thelephora*. Lloyd, Myco. Notes, No. 39, p. 539, referred it to *Sebacina*, and later, Myco. Notes, No. 62, p. 917, to *Institale*, stating that Bourdot has shown that it bears spores directly on the hyphae. I have not found spores in it, other than those of *Fomes applanatus* which have fallen from the host fungus, and the conidia of *Hypomyces chrysostomus* B. & Br., which is parasitic on the *Thelephora*. The mixture was named *Reticularia apiospora* B. & Br. (see Ann. Perad., V, p. 279).

Hymenochaete dura B. & C. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 613, from Thwaites 546. The specimen in Herb. Kew is marked by Thwaites, 546 and 665, with the note, "sent before." It is on *Oncosperma*, and, from the specimens in Herb. Peradeniya, it is Thwaites 665. The fungus forms thick, spongy, red-brown stromata, either pulvinate, up to 5 mm. diameter, or confluent in large patches. The stromata are composed of loosely interwoven hyphae, with a thin, continuous, glabrous, outer layer on the smaller examples. The hyphae are 2-3 μ diameter, yellow-brown, septate, fairly regular, with thin or slightly thickened walls ; they bear spinulose, spore-like, oval bodies, 3·5 x 2·5 μ, each arising just below a septum, and numerous irregular crystals. There is nothing to indicate that this is a *Hymenochaete*. It appear to be a similar species to Thwaites 544, which is referred to *Septobasidium Merrillii* by Bresadola.

Hymenochaete ferruginea Massee. Massee, in Mon. Thelephoreae, p. 103, referred *Stereum ferrugineum* Fr. to *Hymenochaete*, and cited Ceylon as a locality. There is no Ceylon specimen under *Hymenochaete ferruginea* in Herb. Kew. *Stereum ferrugineum* Fr. was recorded for Ceylon by Cesati, with a query and the note "unicum individuum, neque optimum perfecto." Massee's record was probably taken from Saccardo. Lloyd, who has examined Cesati's herbarium, states that his specimen of *Stereum ferrugineum* is surely not that species, but it is not clear whether his note refers to Beccari's Ceylon collection. Until further evidence is available, this name should be deleted from the Ceylon list.

Hymenochaete Mougeotii (Fr.) Massee. In Fungi of Ceylon, No.624, Berkeley and Broome recorded *Corticium Mougeotii* Fr. Massee transferred this species to *Hymenochaete*. No Thwaites number was cited for the Ceylon specimen, and there is no Ceylon specimen under this name in Herb. Kew. Massee did not give Ceylon as a locality for this species, and hence, as he generally took his localities from the named specimens on the herbarium sheets, it may be deduced that there was no Ceylon specimen in Herb. Kew at the time he wrote. The name should be deleted from the Ceylon list.

ALEURODISCUS

Corticium Peradeniae B. & Br., Fungi of Ceylon, No. 629. This is an *Aleurodiscus*, which has been re-described by von Höhnel and Litschauer as *Aleurodiscus Peradeniae* in Beitrage zur Kenntniss der Corticieen, III, p. 16. *Aleurodiscus javanicus* P. Henn. is the same species. See Ann. Perad., IV, p 411.

Aleurodiscus scandens Petch, n. sp. Effused, indefinite, margin feebly byssoid, at first white or cream-coloured, sterile parts remaining white and becoming more or less glabrous, fertile parts yellow, pruinose, general thickness 60-100 μ here and there forming cushions up to 0·5 mm. thick ; in the thicker parts, composed of somewhat loosely interwoven hyaline hyphae, with denser basal and hymenial layers, the latter consisting chiefly of dendrophyses ; in the thinner parts loose and friable, composed of erect hyphae 4 μ diameter, passing into dendrophyses above ; dendrophyses 2-4 μ diameter below, simple or branched, dividing above into a head of spreading conical spines, up to 4 μ long, 0·5-1 μ diameter ; basidia not seen. On dead twigs and leaves, some distance from the ground, Hakgala, January 1914 ; No. 4585.

This is one of a group of species, common in up-country jungles, which fasten together dead or living twigs, or small branches, by means of cushions of hyphae, and so form, when the twigs and branches die, large tangles suspended several feet above the ground. *Panus melanophyllus* has the same habit.

CORTICIUM

Corticium salmonicolor B. & Br., Fungi of Ceylon, No. 640. This is the now well-known fungus which causes the disease known as Pink Disease in the tropics. It was described again by Zimmermann in Java as *Corticium javanicum* Zimm. In compiling vol. XVI of the Sylloge Fungorum, Saccardo and Sydow changed *Aleurodiscus javanicus* P. Henn. to *Corticium javanicum* (P. Henn.) Sacc. & Syd., an alteration which was invalid, owing to the prior existence of *Corticium javanicum*

Zimm. Subsequently, when *Corticium javanicum* Zimm. came to be included, they changed the latter name to *Corticium Zimmermanni* Sacc. & Syd.

Thwaites mixed his specimens of *Corticium salmonicolor* (Thwaites 4) with *Corticium Peradeniae* (Thwaites 199). Berkeley and Broome detected the error, and described the two species correctly, but they did not separate the specimens. Hence Massee's re-description of *Corticium salmonicolor* in Mon. Thelephoreae relates chiefly to *Corticium Peradeniae*.

Corticium tristiculum B. & Br. This was described by Berkeley and Broome from Thwaites 994. Massee in Mon. Thelephoreae transferred it to *Hymenochaete*, but altered the name to *tristiusculum*. Patouillard, in Philippine Journal of Science, vol. X, Sec. C, Botany, p. 87, described the same species as *Duportella velutina*, the type of a new genus *Duportella*.

The fungus is resupinate, seal brown with a paler greyish brown margin, minutely velvety, becoming glaucous when old and cracking irregularly. The thickness of the fructification is 0·1—0·2 mm. The basal layer is thin and compact, composed of hyphae parallel to the substratum. Above that, the context consists of loosely interwoven, stout, fuliginous yellow-brown hyphae which curve upwards into the hymenium. The latter is about 0·04 mm. thick, and consists of a close palisade layer of paraphyses, about 3 μ diameter, with obtuse tips. Occasionally, these paraphyses expand irregularly above to a diameter of 5 μ, and they then somewhat resemble a *Hymenochaete* seta, though comparatively thin-walled. In general, however, the paraphyses are merely the tips of the hyphae, and are not differentiated. They do not project. Among the paraphyses are thin-walled, inflated cystidia with hyaline contents, irregularly fusoid or conoid, sometimes more or less truncate at the base, 40—64 x 16 μ. These arise from the hyphae, and may be situated at any depth in the fructification.

This species does not possess *Hymenochaete* setae and cannot be placed in that genus. The structure of the hymenium recalls that of *Stereum percome*. If Patouillard's genus is not accepted, the fungus should remain in *Corticium*.

Corticium rhabarbarinum B. & Br. Thwaites collected two species in the south of the Island in July 1868, which formed his numbers 656 and 657; he marked the latter, "compare with 656." Berkeley and Broome named the first of these *Corticium reticulatum* (Fungi of Ceylon, No. 628), and the second, *Corticium rhabarbarinum* (Fungi of Ceylon, No. 627). They stated that the two were undoubtedly closely allied, but it would appear from their descriptions that their specimens were mixed. In 1915, the type of *Corticium rhabarbarinum* in Herb. Kew contained

two pieces of *Corticium rhabarbarinum* and two of *Corticium reticulatum*. Berkeley and Broome described both as arising from radiating fibres, but that is true only of *Corticium reticulatum*.

The name *Corticium rhabarbarinum* had previously been applied by Berkeley to a specimen from New Zealand. Cooke, in Grevillea, VIII (1880), p. 148, referred the New Zealand species to *Hymenochaete*, as *Hymenochaete rhabarbarina* Cke., stating that the setae were subconical, 28—30 x 8—9 μ. Ten years later, Massee referred the Ceylon specimen to *Hymenochaete*, as *Hymenochaete rhabarbarina* Massee, citing only the Ceylon record for his type, but giving Ceylon and New Zealand as localities. His description evidently contains details of both the Ceylon specimens and of the New Zealand specimen, i. e., it is a compound of *Hymenochaete rhabarbarina* Cke., *Corticium rhabarbarinum* B. & Br., and *Corticium reticulatum* B. & Br. Miss Wakefield, in Kew Bulletin, 1915, p. 370, re-described the Ceylon *Corticium rhabarbarinum* as *Stereum rhabarbarinum* Wakefield.

Corticium reticulatum B. & Br. was said to be antedated by *Corticium reticulatum* Fr., a name which appears to have vanished. Hence the former name was changed in Sylloge Fungorum, VI (1888) to *Corticium marescalchianum* Manc. & Sacc.; and Massee, in Mon. Thelephoreae (1890), replaced it by *Corticium flavo-virens* Mass. The fungus is a *Septobasidium*, and in Bull. Soc. Myc. France, XXIV (1908), p. 2, Patouillard listed it as *Septobasidium reticulatum* (B. & Br.) Pat.

Stereum rhababarinum Wakefield is a thick, hard, resupinate species which cracks in rather distant lines, chiefly transversely. Berkeley and Broome did not see any difference in colour between this and *Corticium reticulatum*, but stated that the hymenium was "rhabarbarinum" in both. Miss Wakefield describes that of *Stereum rhabarbarinum* as cinnamon, but there is a distinct greenish yellow tinge in certain lights. The hymenium is pruinose. The margin is sub-vertical, glabrous, and dark brown to black. The context, in mass, is pale purple-brown. In sections, it is seen to be closely stratose, and composed of yellow-brown hyphae fused together so that the individual hyphae are indistinguishable. The hymenium contains aculeate paraphyses, obtuse, cylindrical or inflated above, 15-20 x 5 μ. At the base, next the substratum, red-brown resinous masses may be present, both in the stroma and in the host cells, and here and there a red-brown seta arises from the basal layer to a height of about 80 μ.

I have a recent collection which appears to be an old stage of this species. The fructification is pruinose and greyish brown, or purple-brown where the outer layer has weathered off. It is 1·5 mm. thick, cracked in lines at right angles, but chiefly transversely, with a subver-

tical, black, glabrous margin. Internally it is stratose, and of the same structure as the type of *Stereum rhabarbarinum*, but the colour of the tissue is deeper, because of the presence of large quantities of the red-brown resinous substance, which often lies in definite zones between the successive strata. But it differs from the type in containing numerous red-brown setae, which can be detected with a hand lens on a section of the stroma. These setae are 100-375 x 8-12 μ, cylindric, tapering at each end, somewhat flexuose. They arise at all levels in the stroma, not in definite rows, and do not bear any necessary relation to the strata, a single seta running through several strata. They are all completely embedded. It was thought that these might be resinous inclusions; but on heating a section of the fungus in concentrated nitric acid the setae persist, while the red-brown resinous substance disappears. The setae have a narrow central cavity, and are similar to normal *Hymenochaete* setae. They differ from the latter in that they are all embedded, and do not arise in association with the successive strata of the fructification.

Obviously it would appear at first sight that this recent collection is distinguished from *Stereum rhabarbarinum* by the presence of setae, and must be a different species. But although sections of the type of *Stereum rhabarbarinum*, in general, do not show any setae, they do occur occasionally, arising from the base of the stroma. It is possible that, in that position, they have not been distinguished from the red-brown resinous deposits which are often situated in pockets at the base of the stroma. The two fungi resemble one another so closely in other respects, that it would appear probable that they are the same species, the development of these internal setae occurring only when the fructification is old.

Corticium flavo-rubens B. & Br., Fungi of Ceylon, No. 647. As stated in Ann. Perad., VI, p. 157, this species also furnished the record of *Stereum sulphureum* Fr., and is no doubt the basis of the record of *Corticium sulphureum* Fr. and *Stereum strumosum* Fr., for Ceylon.

As previously described, this species forms small patches, usually irregularly oval, up to 8 mm. in diameter and 0·5 mm. thick, powdery, usually with a definite rounded tomentose margin. These are at first bright yellow, but become orange-yellow owing to the development of a large number of minute, red-brown bodies on or near the surface. Internally they are white, composed of interwoven hyphae, 1-2 μ diameter, encrusted with calcium oxalate. The red-brown bodies, which occur in the upper layer, are oval or irregular, amorphous, up to 24 x 20 μ. Basidia have been found only in a very early stage, when the fungus is a thin, powdery, yellow patch on the bark. In this stage, there is practi-

cally no basal layer, the basidia being perpendicular to the bark, mixed with scattered, erect, branched, yellow hyphae, 1·5 μ diameter, sometimes loosely interwoven. The basidia are somewhat scattered, oblongo-clavate, 60-100 x 24-32 μ, four-spored, the sterigmata being up to 24 μ long, 5 μ diameter below, attenuated upwards, narrow flask-shaped. The spores are globose, 26-32 μ diameter, or pyriform, pedicellate, with coarsely granular contents, and often adhering in fours.

Corticium suffultum B. & Br., Fungi of Ceylon, No. 651. Berkeley and Broome stated that this was analogous to *Thelephora pedicellata*. It is a *Septobasidium*, and has been described by Patouillard in Bull. Soc. Myc. France, XXXVI, p. 175, as *Septobasidium leucostemon*, the name *Septobasidium suffultum* having already been employed for *Thelephora suffulta* B. & Br.

Corticium modestum B. & Br. This was described by Berkeley and Broome in Fungi of Ceylon, No. 626, from Thwaites 992. Massee, in Mon. Thelephoreae, transferred it to *Hymenochaete*. The colour was said to be yellowish grey, with a yellowish margin. The specimens are now brownish grey with a paler margin. It has not been collected again. It is resupinate, forming at first circular patches which ultimately coalesce, sometimes zoned, separable from the substratum, with the dorsal surface matted silky tomentose. The total thickness is about 0·2 mm. The dorsal layer consists of loosely interwoven, pale yellow-brown hyphae more or less parallel to the substratum, and merges without any definite demarcation into the denser subhymenial layer. Gloeocystidia, about 5 μ diameter, curve upwards from the subhymenial layer, and may project about 12 μ, their apices being minutely verrucose and only slightly inflated. This is not a *Hymenochaete*, but a *Stereum* (*Lloydella*), and it will stand as *Stereum* (*Lloydella*) *modestum*.

Corticium alopecinum B. & Br., Fungi of Ceylon, No. 631. This species grew on bark, from which it was evidently readily separable. The specimens, Thwaites 1034, in Herb. Peradeniya, have, for the most part, been peeled off the substratum. They show various stages of development. In places, the fungus consists merely of a very thin, red-brown, continuous membrane, formed by loosely interwoven, yellow-brown hyphae, agglutinated into a continuous sheet. On this sheet are situated effused, rather loose and spongy, flat masses of yellow-brown hyphae ; and in the fully-developed parts these are covered by a thin grey layer which can be peeled off from the spongy context. The fully-developed parts are up to 0·5 mm. thick. The basal layer is a very thin continuous film. The context is loose, composed of regular, septate, branched, yellow-brown hyphae, which divide above into numerous short, hyaline, irregular branches. The upper, slightly denser, hymenial

layer is composed of these branches, with numerous globose, yellow-brown bodies, 11-13 μ diameter, or oval, 12 x 10 μ. These are evidently probasidia; and the fungus is a *Septobasidium*, which may stand as *Septobasidium alopecinum* (B. & Br.).

Corticium murinum B. & Br., Fungi of Ceylon, No. 635 was transferred to *Coniophora* by Massee. It is a *Septobasidium*, which may be known as *Septobasidium murinum* (B. & Br.).

Corticium muscigenum B. & Br., Fungi of Ceylon, No. 638. This species is not uncommon at Hakgala. It grows on the old decaying bark of living trees. The mycelium is white, and runs in a network of strands, up to 0·5 mm. diameter, among the bark scales, here and there producing white byssoid patches on which the fructification is developed. The mature fructification is usually more or less circular, often irregularly angular, 1-2 cm. diameter, fawn-coloured, with a white margin at first, pruinose, soft and spongy, up to 1·5 mm. thick. Internally it is white, or zoned, white and pale brown, soft and friable. The basal layer is thin, felted tomentose, white to brown when viewed from below, yellow to yellow-brown in section. The context is composed of loosely interwoven, thin-walled, hyaline hyphae, 1-3 μ diameter, and contains numerous small, spherical crystals of calcium oxalate. The basidia are clavate, 4-6 μ diameter, four-spored, with slender sterigmata. The spores are oval, hyaline, minutely spinulose, 5-6 x 3-4 μ. It has no resemblance to *Aleurodiscus Peradeniae*, *Peniophora sparsa*, or *Corticium scariosum*, to which Berkeley and Broome compared it.

Corticium scariosum B. & Br., Fungi of Ceylon, No. 548. This was described as " Ochroleucum scariosum, hymenio glabro e mycelio arachnoideo oriundo, demum subsecernibile (No. 548). On dead wood. Forming thin patches which at first consist of arachnoid fibres, which after a time are partially collected together and run over the first in the form of thin threads. Though somewhat resembling *C. Peradeniae* and *salmonicolor* there is a material difference." Massee stated that the spores were globose, 7-8 μ diameter.

The specimens on dead wood are effused, thin patches, powdery in some parts, glabrous in others, cracked, pale ochraceous. At the margin there may be a thin byssoid film, traversed by a few definite strands. The thickness of the fructification is about 0·1 mm. The basal layer is an extremely thin weft of hyaline hyphae, 1-5 μ diameter. The context is composed of the same hyphae, densely interwoven and enclosing numerous crystals of calcium oxalate. The surface consists of a layer of cuboid cells about 10 μ deep. Basidia were not found.

In Herb. Peradeniya, there are other specimens under Thwaites 548, on bark. These consist of a coarse byssoid layer of hyphae, extend-

ing indefinitely, probably white when fresh. The hyphae are up to 8 μ diameter. This appears to be a different species.

Corticium scariosum does not bear any resemblance to *C. Peradeniae*, and very little to *C. salmonicolor*.

Corticium caeruleum Fr. Recorded for Ceylon in Fungi of Ceylon, No. 642. Common at Hakgala. Ceylon specimens are deep Prussian blue, becoming almost black in the older parts, sometimes with a narrow white margin. Thickness 0·15 mm. Basal layer, loose, fuscous, composed of pale yellow-brown hyphae, 4 μ diameter; intermediate tissue white, of hyaline, thick-walled hyphae, up to 5 μ diameter; sub-hymenial tissue blue. The basidia do not appear to exceed 30 μ in length.

Corticium simulans B. & Br. Berkeley and Broome described this as "Molle, fulvum, e strato albo floccoso membranaceo oriundum; hymenio laevissimo (No. 340). Running over mosses. At first sight resembling *Merulius Corium*. Spores subelliptic, .0003 long." In Ann. Myc., IX (1911), p. 271, Bresadola recorded a specimen from Africa as *Hymenochaete simulans* (Berk.) Bres., citing *Corticium simulans* B. & Br. as a synonym. He stated it had brown setae, 80-100 x 7-9 μ, and hyaline spores, 7-10x4-5 μ. von Höhnel and Litschauer had previously (1907) referred this species to *Hymenochaete*, having apparently based their opinion on the American fungus which Berkeley recorded under the same name. The Ceylon specimen, however, is not a *Hymenochaete*, and the type in Herb. Kew bears a note to that effect by Lloyd, with the spore measurement, 7 x 3 μ.

The specimen in Herb. Peradeniya consist of a membranous film, deep ochraceous, overrunning mosses, here and there containing evident strands, and sometimes appearing thicker and horny. Where the hymenium is developed, the fungus is glabrous, waxy, red-brown, and very fragile. The thickness is 0·1-0·2 mm. The texture of the stroma is compact, except at the extreme base. The basal hyphae are up to 4 μ diameter, thin-walled. The basal half of the stroma is hyaline in section, the upper part yellow-brown. The basidia are clavate, 24 x 4 μ.

Corticium ambiens B. & Br., Fungi of Ceylon, No.649. Berkeley and Broome described this species as "candido", Massee, as pure white with a slight tinge of ochre or pink. The part of Thwaites' specimen in Herb. Peradeniya is now pale ochraceous, with here and there a narrow, white, byssoid margin, effused, very smooth but not shining. Where it is cracked, the exposed white, basal layer appears chalky. The thickness is about 0·3 mm. The basal layer is white, and contains large numbers of irregular masses of calcium oxalate. The intermediate tissue is compact, composed of irregular spiny hyphae, 2 μ diameter, agglutinated so that the individual hyphae are almost indistinguishable.

The basidia are cylindric, 4 μ diameter. This does not appear to be related to *Stereum duriusculum*, though it resembles the latter in some respects.

Corticium emplastrum B. & Br., Fungi of Ceylon, No 632. This was described as " Effusum tenue, substrato niveo marginem angustum efformante ; hymenio glaberrimo alutaceo rimoso. Forming little confluent patches about half an inch wide ; margin very narrow, byssoid ; the whole looking like a little plaister." It is a common species, frequently occurring on dead branches of *Hevea*. It is much more extensive than in the type, and often covers an area six or eight inches long, and four to six inches wide. The fructification is at first white, somewhat fibrillose, becoming glabrous and porcellanous, and changing colour on the older parts to yellow-brown, then red-brown, somewhat irregularly so that it appears stained. The thickness is about 0·4 mm. The context is white, and composed of loosely interwoven, irregular, hyaline hyphae, 2-3 μ diameter. The surface layer is about 16 μ thick, yellow-brown in section, and composed of hyphae more or less parallel to the surface, agglutinated into a solid layer, with an amorphous yellow-brown deposit. The surface layer cracks, and exposes the white internal tissue. No hymenium has been observed in this species.

Corticium albovirescens Petch, n. sp. Effused, spreading indefinitely, membranous, white, becoming glabrous, shining, and porcelain-like, developing here and there fairly large greenish-grey hymenial patches ; total thickness up to 0·3 mm. ; basal layer of hyaline hyphae, 2-3 μ diameter ; subhymenial hyphae with brown or olive contents ; basidia oblong or oblong-oval, 26 x 10 μ, with four slender sterigmata up to 6 μ long, accompanied by somewhat irregular paraphyses, 4 μ diameter, sometimes forked at the apex ; spores hyaline, minutely warted, narrow-oval, inequilateral, 8-10 x 4 μ. On dead wood, Hakgala, April 1919 ; No. 5960.

Corticium cacaoicolor Petch, n. sp. Effused, indefinite, pale chocolate, glabrous, waxy, with a broad greyish white, sometimes pruinose, margin ; 0·1-0·2 mm. thick, the basal layer, about one-third the total thickness, hyaline, of loosely interwoven hyphae, the upper part compact, subtranslucent, pale yellow in section ; basidia 5 μ diameter, sterigmata 3 μ long, spores hyaline, oblong-oval, 7 x 3 μ. On a dead branch, Peradeniya June, 1915 ; No. 4697.

Corticium flavocarneum Petch, n. sp. Effused ; at first ochraceous yellow, becoming pinkish ochraceous, with a broad, irregular, byssoid margin, turning purplish where bruised ; old herbarium specimens salmon pink, with a white margin ; pulverulent, soft ; 0·1 mm. thick, context of loosely interwoven, hyaline, regular hyphae, 3-4 μ diameter below,

curving upwards and branching at a wide angle, the branches terminating in clusters of clavate basidia and paraphyses which form a continuous hymenium ; basidia clavate, 5-6 μ diameter ; paraphyses 3-4 μ diameter, minutely spinulose ; spores hyaline, oval, minutely spinulose, 6-8 x 3-5 μ. On a dead branch, Hakgala, April 1915 ; No. 4672.

Corticium corneum Petch, n. sp. Resupinate, effused, glabrous, horny, dull orange ; in section white below, dull orange and translucent above ; thickness 0·2-0·4 mm. ; lower part, up to 0·1 mm. thick, of loosely interwoven, hyaline hyphae, upper part of vertically agglutinated hyphae, constituting the greater part of the stroma, with irregularly spherical crystals of calcium oxalate scattered throughout ; basidia 4 μ diameter, cylindric, expanding slightly above, sterigmata conical, very short ; spores hyaline, narrow-oval, inequilateral, minutely warted, 7-9 x 4-6 μ. On wood, Peradeniya, Nov. 9, 1915 ; No. 4778.

Corticium farctum Petch, n. sp. Effused, white, becoming pale ochraceous, with white sterile patches, and, at first, a broad, white, pruinose margin, smooth, waxy, spreading in patches up to 20 cm. long and 15 cm. broad ; fructification 0·12 mm. thick, lower half hyaline in section, upper half pale yellow ; basal layer thin, yellow, or wanting ; lower half composed of loosely interwoven, somewhat rigid, hyaline, thick-walled or solid, refringent hyphae, 1·5 μ diameter ; upper half compact, of agglutinated hyphae ; basidia ovoid or pyriform, attenuated below into a stalk, up to 18 μ long, 6-8 μ diameter, four-spored ; sterigmata short, about 2 μ ; spores oval, inequilateral, hyaline, 8 x 3 μ. On dead coriaceous leaves, Gikiyanakande, June 1916 ; No. 5661. The hyaline hyphae stain purple-brown with iodine.

Corticium (Gloeocystidium) endovirgatum Petch, n. sp. Resupinate, effused, pale brown or fawn, with a paler byssoid margin, pruinose, up to 0·9 mm. thick ; lower part, up to 0·7 mm. thick, loose and spongy, composed of loosely interwoven, slender, hyaline hyphae, separated from the upper part by a narrow, red-brown zone, about 16 μ thick, composed of parallel hyphae ; upper part composed of loosely interwoven, hyaline hyphae for about half its thickness, passing into the compact hymenial layer ; upper layer and hymenium traversed by numerous, irregular gloeocystidia, 6-8 μ diameter, with brown or yellow-brown contents ; spores hyaline, oval, 5 x 3 μ. On wood, Henaratgoda, August 1916 ; No. 5212.

Corticium comedens Fr. This was recorded for Ceylon by Berkeley and Broome in Fungi of Ceylon, No. 652, from Thwaites 623. They stated that it presented nothing more than a very thin, pulverulent hymenium. Thwaites 631 was said to differ in being a purer white.

In Thwaites 623, the fungus develops beneath the outer layer of the bark, which splits and recurves in more or less triangular scales, exposing irregular patches, up to 7 x 4 mm. These patches are greyish white and powdery. They consist of a very thin film of irregular spinulose hyphae, 1-2 μ diameter, which bear minute, hyaline spores, about 1 μ diameter, or 1·5 x 1 μ. A few spinulose hypha tips, up to 6 μ long, may stand erect. No. 631 is the same, but the patches are smaller, about 1 mm. diameter. There is nothing which would indicate that this is a *Corticium*, and the name should be deleted from the Ceylon list.

Corticium incarnatum Fr. This was recorded for Ceylon by Berkeley and Broome from Thwaites 986, the specimen being said to be parasitic on a byssoid *Sphaeria*. It is not possible to say what it is from the herbarium specimens. It does not appear to be parasitic on a *Sphaeria*. The stroma contains vertical red-brown structures which appear to be part of the host plant.

Corticium chlorascens B. & Br. Massee, in Mon. Thelephoreae, stated that this was an immature byssoid *Nectria*. It is an immature Hypocreaceous fungus, but apparently *Hypocrea*.

Corticium peroxydatum B. & Br., Fungi of Ceylon, No. 633. Massee transferred this to *Coniophora*. As previously stated (Ann. Perad., VI, p. 157), it is an immature *Hypoxylon*.

Corticium calceum Fr. This was recorded for Ceylon by Berkeley and Broome from Thwaites 329 in part. That Thwaites's number provided *Stereum duriusculum* B. & Br. There is no Ceylon specimen included under *Corticium calceum* in Herb. Kew.

Corticium tenuissimum B. & Br., Fungi of Ceylon, No. 637. This was described as "suborbiculare tenuissimum subglaucum, margine albo annulo rufo cincto (No. 998)." Massee (Mon. Thelephoreae) added that the colour was silver grey, and that the spores were oblongo-ellipsoid, 8 x 6 μ. The specimen in Herb. Peradeniya bears a note by Thwaites, "disk pale grey, blue when fresh." The stromata are about 5 mm. diameter, usually circular, brownish grey, or dark grey with a paler margin, with sometimes an intermediate yellowish zone, glabrous, about 100 μ thick in the centre, 40 μ thick elsewhere. Sections show that it is an immature lichen, the thallus containing alga cells in chains.

Corticium hypochnoideum B. & Br. This, described in Fungi of Ceylon, No. 641, was attributed to "B. & C." It was said to be "Pusillum stellato-orbiculare rubrum, margine elevato; hymenio demum atro-vinoso. Sometimes erumpent, sometimes superficial, with a narrow white border. Analogous to *Stereum ruberrimum*." Massee listed it as a doubtful species. The fungus is erumpent, oval, 1·5 x 0·7 mm., or

circular, about 1 mm. diameter, dark crimson, or purplish red. The white pulverulent border consists partly of fungus tissue and partly of fragments of bark. Sections show that it is undoubtedly an immature ascomycete. Thwaites marked the part of the gathering which he kept "? *Stictis*."

ASTEROSTROMA

Asterostroma apalum (B. & Br.) Massee. This, the type species of the genus *Asterostroma*, was described by Berkeley and Broome as *Corticium apalum* in Fungi of Ceylon, No. 648. They stated that it was nearly allied to *Corticium Habgallae*, a white, subgelatinous *Peniophora* to which it has no resemblance. When fresh, it is yellow-brown at first, with a white byssoid margin, becoming pinkish buff when mature, powdery, soft. The fructification is about 0·3 mm. thick, internally loose, spongy, and pale pinkish brown. It is composed almost entirely of pale yellow-brown, stellate hyphae, with arms, 20-36 x 3 μ, attenuated outwards, sometimes forked, the arms of each star being approximately equal. In the surface layer some have arms only 8 x 2 μ. The basidia are oval or subglobose, four-spored,4-8 x 3-6 μ, with conical sterigmata, 2 μ long. The spores are hyaline, fusoid, 6 x 1·5 μ.

Asterostroma degenerans Bres. This was detected by Bresadola in *Hymenochaete depallens*, Thwaites 145, in Herb. Kew, and was described by him in Ann. Myc., XVIII (1920), p. 49. The same mixture occurs in the corresponding specimen in Herb. Peradeniya. The fungus is purple-brown, here and there with a greyish superficial film, farinose, with numerous, dark brown, projecting setae. The context is loose, and reddish brown. The fructification is about 0·2 mm. thick, or in places stratose and up to 0·7 mm. thick. The setae are deep yellow-brown, 80—130 x 12—14 μ, with sub-horizontal, stellate bases of usually three rays, each up to 50 μ long, 5 μ diameter, tapering outwards. The stellate bases of the setae interlace, and, with a few hyaline hyphae, form a superficial layer about 40 μ thick. Internally the structure is loose, and consists of stellate hyphae, pale yellow-brown, with numerous rigid, spreading rays, about 50 μ long, 3—5 μ diameter, sometimes forked. Sometimes two stellate clusters are united by a short isthmus.

Massee founded the genus *Asterostroma* on *Corticium apalum* B. & Br. The latter is a *Corticium* with stellate hyphae in the context. In the present species, the stellate hyphae are of two kinds, the longer branches of the larger projecting above the surface. This species is consequently a *Hymenochaete* with stellate hyphae in the context. Logically it should be placed in a new genus.

PENIOPHORA

Peniophora Habgallae (B. & Br.) Cooke. Berkeley and Broome described this in Fungi of Ceylon, No. 645, as *Corticium Habgallae*. Cooke transferred it to *Peniophora* in Grevillea, VIII, p. 20, and gave a re-constructed figure of it in Mycographia. It has occurred during the last sixteen years on dead branches of *Cinnamomum Camphora* at Hakgala. Neither the published figure nor the descriptions give any idea of the fungus when fresh. Berkeley and Broome stated that it was elevated on one side, and hence Massee considered that it formed a transition from the truly resupinate to the reflexed species, but that appearance must have been the result of drying.

When fresh, the fungus is pezizoid, circular or oval, regular or somewhat lobed, up to 1·5 cm. diameter, the upper surface plane or undulating, white, or pallid with a white margin; thickness up to 3 mm.; externally white, slightly tomentose, rounded and contracted below and centrally attached; fragile when fresh; shrinking when dry to a thin disc, 0·5—1mm. thick. Cortex at base and sides 0·1 mm. thick, white, fleshy; internal tissue subgelatinous. Hymenium about 0.15 mm. thick; cystidia hyaline, flask-shaped or conical, wall slightly thickened, encrusted, 80—100 μ high, 14—20 μ diameter below, projecting up to 66 μ; basidia clavate, up to 18 μ diameter above, four-spored; sterigmata stout, conical, about 6 μ high; spores oval, smooth, hyaline, 16—21 x 12—14 μ.

Peniophora lilacina (B. & Br.) Massee. This was described by Berkeley and Broome as *Corticium lilacinum*, Fungi of Ceylon, No. 634. The colour was said to be "e lilacino pallescens, margine albo tomentose." The specimens are now purple-brown. They are resupinate, plane or tuberculate, sometimes with coarsely tomentose, marginal areas. They are up to 0·8 mm. thick, compact and brownish white internally. The extreme basal layer is red-brown to yellow-brown, translucent, about 50 μ thick, composed of agglutinated hyphae, parallel to the substratum. The intermediate tissue is composed of irregular, hyaline, thick-walled hyphae, more or less vertical. The hymenium is brown in section. The cystidia arise at all depths, from stout hyphae, 8 μ diameter, which traverse the context subvertically. Some cystidia are entirely embedded, others project up to 70 μ; they are 12—16 μ diameter, cylindric, conical above, obtuse, encrusted, hyaline, becoming brownish.

Bresadola, in Ann. Myc., XIV, p. 242, states that this species does not differ much from *Peniophora velutina* (DC.); he describes the cystidia as clavate, 140—150 x 9—12 μ.

Peniophora gigantea (Fr.) Massee. Recorded for Ceylon in Fungi of Ceylon, No. 643, as *Corticium giganteum* Fr. The Ceylon specimens

spread widely over dead wood or earth, and are horny when dry. The thickness of the fructification is about 0·5 mm. The greater part of the thickness, 0·4 mm., consists of a red-brown, horny layer, pale yellow in section, interrupted here and there by pockets containing a loose network of hyphae, 2—3 μ diameter. Above this horny layer is a narrow hyaline zone, about 50 μ thick, of loosely interwoven hyphae; and above that another yellow, horny layer, 30—50 μ thick. The hymenium forms a thin film on the surface. Cystidia occur on the older parts, and are conical, obtuse, hyaline, strongly encrusted, 30—55 x 14—16 μ. This does not appear to agree completely with recent descriptions of the European species.

A recent young specimen was, when fresh, red-brown in the centre, becoming orange outwards, with a white margin. This does not show the doub'e structure in the upper part.

Peniophora sparsa (B. & Br.) Cooke. This was described by Berkeley and Broome as *Corticium sparsum*, Fungi of Ceylon, No. 650. Cooke, in Grevillea, VIII, p. 21, transferred it to *Peniophora*. It has been re-described by von Höhnel and Litschauer in Beiträge zur Kenntnis der Corticieen III, from specimens and data supplied from Ceylon.

Peniophora stratosa Petch, n. sp. Effused, cream-coloured, even, compact, up to 0·35 mm. thick ; internally white, stratose, hyaline in section with yellow zones ; basal layer thin, compact, composed of hyphae parallel to the substratum, intermediate tissue rather loose, composed of irregular agglutinated hyphae with numerous interspaces ; basidia, clavate, 6-8 μ diameter ; cystidia at all depths, hyaline, conical, encrusted, almost solid, 80-110 x 15-30 μ, projecting up to 70 μ ; spores broadly oval or oblong-oval, hyaline, 8-12 x 6 μ. On a dead branch, Peradeniya, May 1915 ; No. 4677 in Herb. Peradeniya.

Peniophora fisso-reticulata Petch, n. sp. Widely effused, white, cream-coloured in the thicker parts, margin abrupt, or merging into extensive powdery patches, cracking into numerous, rather widely separated, irregular lines and small patches ; thickness about 0·1 mm. ; no definite basal layer ; context of hyaline, interwoven hyphae running more or less vertically ; basidia clavate, 3-4 μ diameter ; cystidia irregularly conical or cylindric, obtuse, encrusted, hollow towards the apex, 16-24 x 8-9, μ projecting up to 20 μ ; spores oval, hyaline, 4-6 x 2·5-3 μ. On dead branches, Peradeniya, May 1915 ; No. 4689 in Herb. Peradeniya.

Peniophora excurrens Petch, n. sp. Mycelium ochraceous yellow, spreading widely over mosses, leaves, chips of wood, etc., in coarse strands which are subsequently united by thin byssoid sheets on which the hymenium is developed. Hymenium pale purplish grey or reddish grey, pruinose ; margin yellow, byssoid ; lower surface byssoid, yellow ;

context spongy, yellow or pale brown in section. Thickness up to 0·6 mm.; basal layer thin; context of strongly encrusted, yellow hyphae, 3-4 μ diameter, loosely interwoven ; hymenial layer red-brown, sometimes stratose. Cystidia up to 64 μ long, 8-10 μ diameter, conical or cylindric, strongly encrusted, obtuse, projecting up to 50 μ ; basidia cylindric, 4 μ diameter, accompanied by strongly encrusted, cylindric, yellow hyphae projecting up to 30 μ ; spores oval, minutely warted, pale yellow, 4 x 2 μ. Hakgala, fairly common ; type, No. 4575, January 1914.

In one collection of this species, the fructification is not stratose, and the cystidia are hyaline and project strongly. In other collections, the stroma is stratose, and shows three successive hymenia, the upper part consisting of alternate yellow and red-brown layers. The cystidia in these latter specimens do not exceed 50 μ, do not project more than 16 μ, and are yellow. In parts of these specimens, the hymenium is waxy, red-brown, and cracks on drying, and the fungus, when growing on wood, may develop a compact, red-brown, basal layer. The parts with a smooth hymenium resemble *Corticium simulans* in appearance, and the latter has similar mycelium, but it lacks cystidia and its hyphae are different.

Peniophora decidua Petch, n. sp. Dark slate coloured, with a narrow, blackish brown margin, pruinose, forming oval or circular patches, about 1 cm. x 5 mm., or confluent in irregular patches, about 2 x 1 cm. ; thickness 0·05-0·1 mm., basal layer none, fructification composed of irregular stout hyphae, more or less vertical, 3 μ diameter, hyaline above ; cystidia conical, hyaline, encrusted, up to 36 μ high, projecting up to 20 μ, with similar, vertically-oval bodies entirely embedded in the stroma, both ultimately falling out and leaving very minute holes ; basidia expanding upwards, 8 μ diameter, sterigmata short, 3 μ long. On dead *Hevea*, Pallegodde, January 1912 ; No. 3350.

THELEPHORA

The majority of the species assigned to *Thelephora* in the Fungi of Ceylon are *Septobasidium*.

Thelephora atropurpurascens B. & Br., Fungi of Ceylon, No. 580, was transferred to *Punctularia*, as *Punctularia atropurpurascens* (B. & Br.) Petch, in Ann. Perad., VI., p. 160.

Thelephora submembranacea B. & Br., Fungi of Ceylon, No. 584, was described as " Late effusa, secernibilis, hymenio fulvo-umbrinoe sporis pulverulento (No. 987). Spores tawny, oblique, ·00028 long." Cooke, in Grevillea, VIII., p. 89, transferred it to *Coniophora*, and Massee, Mon. Theleph., stated that the spores were elliptico-fusoid, 10-12 x 5 μ

The specimen, Thwaites 987, in Herb. Peradeniya has been detached from the host and gummed on paper, but it is cracked into rather small pieces. It is widely effused, purple-brown to tawny brown, and not now markedly pulverulent. It is 0·3 mm. thick, yellow-brown internally. The context consists of irregular hyphae, 1-2 μ diameter, rather loosely interwoven and containing masses of calcium oxalate in the lower part, but dense above. In the upper part of the stroma, irregular hyphae about 4 μ diameter run more or less vertically, and these divide into irregularly flexuose branches, 2-4 μ diameter, which form the hymenium. The spores are yellow-brown, narrow oval, inequilateral, or somewhat attenuated to the distal end, with a prominent excentric apiculus, 5-9 x 3-4 μ, and resemble the spores of an agaric. They are situated throughout the upper third of the fungus, with a definite red-brown zone of spores at a depth of about 80 μ from the surface. I have not been able to determine basidia.

Thelephora cristatella B. & Br., Fungi of Ceylon, No. 572. This was described as " Pusilla, nivea, cuneiformis, deorsum tomentosa, sursum acute cristato-divisa. Whole plant half an inch, wedge-shaped, tomentose below, above divided in a crest-like manner into a few very acute radiating divisions ".

The specimens in Herb. Peradeniya (Thwaites 1021) are 8 mm. high, flattened, fan-shaped or wedge-shaped, 0·5-1 mm. diameter below, expanding to a breadth of 5 mm. above and dividing at the upper edge, into numerous long, conical teeth. Apparently they were erect in growth. The dorsal (?) surface is strongly longitudinally ridged with coarse fascicles of agglutinated hyphae, which sometimes terminate in free, slightly recurved points, similar to the marginal teeth. The other side is also ridged, but not so strongly. The fungus is white, or cream coloured, and tomentose, the marginal teeth appearing yellowish and horny. In cross section at about half the height of the fungus, the thickness is about 0·7 mm. The section shows an external, white, somewhat loose tissue, composed of hyaline hyphae, 2-3 μ diameter, with a narrow, irregular, translucent, middle layer, interrupted here and there, which appears to be formed by the coalescence of adjacent bundles of vertical fibres. The white tissue also contains, in cross section, minute, scattered, translucent areas, which are the sections of the cores of the ridges seen on the surface. Thus the middle layer of the fungus is horny, and it is this layer which divides up into the marginal fringe. Basidia have not been observed. The specimens are apparently immature. Though originally collected at Peradeniya, it has not been recognised again.

Thelephora reticulata Petch, n. sp. Total height up to 2 cm., consisting of a number of pilei arising from a common base, and forming a rosette up to 1·5 cm. diameter; individual pilei narrowly stalked, about 1 mm. diameter below, wedge-shaped, or divided into wedge-shaped lobes almost down to the base; lobes about 2 mm. broad, shortly divided at the apex into obtuse, bicrested segments or into conical teeth; purple-black when fresh, and appearing glabrous and cartilaginous, with purple-brown subtranslucent tips; when dry blackish brown, pale brown or ashy at the tips, tomentose at the base, minutely reticulated above and pruinose or minutely tomentose, coriaceous; thickness of individual lobes 0·5 mm., internally rather loose; spores pale purple-brown, irregularly oval, 8-12 x 4-7 μ, or globose, 6-8 μ diameter, nodular. On the ground, Peradeniya, August 1921; No. 6522.

Cesati recorded *Thelephora multipartita* Fr. var. *fuscella* from Sarawak and Ceylon. Lloyd, who has examined Cesati's specimen, states that it is not *Thelephora multipartita*, and has named it *Thelephora fuscella*. His photograph of the type shows a larger species, and less divided, than that described above. Whether the specimen photographed is from Ceylon or Sarawak, or whether there are two examples in the type, from Sarawak and Ceylon respectively, is not evident.

ODONTIA

Peniophora ambigua (B. & Br.) Massee. This species was founded by Massee on *Hydnum ambiguum* B. & Br. (Thwaites 974). Berkeley and Broome described it as having "aculeis minutis dense approximatis rimoso-congestis tomentosis," and stated that the prickles were so small that they were scarcely visible to the naked eye. Massee found cylindrico-fusoid cystidia, 50-60 x 12-14 μ, and stated that the plant presented "the appearance of a resupinate *Hydnum*, the fascicles of cystidia closely resembling the spines of the last mentioned genus."

The fungus in Thwaites 974 is resupinate, pinkish ochraceous, with a narrow white margin. From a very thin, sometimes arachnoid, basal layer, there arise numerous processes, closely crowded together. These processes are about 0·3 mm. high, and 0·1-0·2 mm. thick; they may be cylindric, or conoid, or thin plates which are curved laterally and sometimes form a hollow cylinder. Here and there they are fused into small tufts, or pulvinate patches, irregularly crested above. The processes or plates are composed of vertical hyphae, the tips of the shorter curving outwards to form paraphyses. Cystidia occur on the basal layer and over the processes; they are cylindric, obtuse, up to 50 x 6 μ, hyaline, and verrucose. The shorter clavate paraphyses are also verrucose.

This species is neither a *Hydnum* nor a *Peniophora*. The processes are not fascicles of cystidia. It would appear to be nearest to *Odontia*, and, *Odontia ambigua* being preoccupied, it may stand as *Odontia conferta* nom. nov.

Odontia membranacea Petch, n. sp. Mycelium white, spreading in radiating dendritic strands over decaying wood, mosses, etc., ultimately fusing into continuous sheets ; hymenium at first pinkish, then pale brown with a pink tinge, brownish white when dry, pruinose, margin byssoid ; stroma separable, up to 0·2 mm. thick, composed of loosely interwoven, slender, hyaline hyphae ; processes scattered, conical or cylindric, sometimes forked, up to 0·2 mm. high,50–100 μ diameter, of rather loose, more or less erect, hyaline hyphae, the free ends of which are encrusted with large crystals of calcium oxalate. Hakgala, October 1914 ; No. 4749.

TOMENTELLA

Tomentella porphyrea Petch, n. sp. Effused, at first byssoid, becoming spongy, tomentose, nodular, purple-grey to purple-brown with a white, byssoid margin. Thickness up to 0·2 mm., context of loosely interwoven, thin-walled hyphae, pale brown to hyaline, up to 8 μ diameter, with prominent clamp connections ; basidia clavate, 10 μ diameter, four-spored, sterigmata conical, up to 10 μ long ; spores slightly irregularly oval or globose, purple-grey in mass, pale purple-brown by transmitted light, coarsely spinulose, 6–11 x 5–8 μ, or 7–8 μ diameter. On fragments of wood and bark, Hakgala, May 1912 ; December 1917. Type, No. 5521 in Herb. Peradeniya.

The thinner byssoid stromata retain their purple-brown colour in the herbarium ; the thicker specimens become yellowish grey.

SEPTOBASIDIUM

It is hoped to publish a separate account of the Ceylon species of *Septobasidium*. Meanwhile, the following synonymy may be recorded.

Thelephora pedicellata Schw., Fungi of Ceylon, No. 574 = *Septobasidium pedicellatum* (Schw.) Pat. ? Burt states that *Septobasidium pedicellatum* Pat. from Cuba is not the same as *Thelephora pedicellata* Schw. The Ceylon specimens under this name, Thwaites 342, are a mixture.

Thelephora suffulta B. & Br., Fungi of Ceylon, No. 575 = *Septobasidium suffultum* (B. & Br.) Pat., Essai Taxonomique (1900), p. 10 *Septobasidium suffultum* (B. & Br.) Bres., Ann. Myc., XIV. (1916), p. 241.

Thelephora dictyodes B. & Br., Fungi of Ceylon, No. 576 = *Septobasidium dictyodes* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV p. 2 (1908) = *Septobasidium dictyodes* (B. & Br.) Bres., Ann. Myc. XIV (1916), p. 241.

Thelephora capnodes B. & Br., Fungi of Ceylon, No. 577 = *Septobasidium capnodes* (B. & Br.) Bres., Ann. Myc., XIV (1916), p.241.

Thelephora lichenicola B. & Br., Fungi of Ceylon, No. 578 = *Septobasidium lichenicolum* (B. & Br.) Petch, Ann. Bot., XXV (1911), p. 842.

Thelephora Thwaitesii B. & Br., Fungi of Ceylon, No. 583 = *Septobasidium Thwaitesii* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV (1908), p. 2.

Thelephora arachnoidea B. & Br., Fungi of Ceylon, No. 581. Burt, Ann. Missouri Bot. Gard., III, p. 214, states that this is *Hypochnus umbrinus* (Fr.) Burt = *Thelephora umbrina* Fr. Bresadola, in Ann. Myc., XIV (1916), p. 241, refers it to *Septobasidium*, as *Septobasidium arachnoideum* (B. & Br.) Bres. The latter appears to be correct.

Thelephora subcarbonacea B. & Br., Fungi of Ceylon, No. 582 = immature *Septobasidium arachnoideum* (B. & Br.) Bres.

Thelephora accumbens B. & Br., Fungi of Ceylon, No. 585 = *Septobasidium accumbens* (B. & Br.) Bres., Ann. Myc., XIV (1916), p. 241.

The specimen, Thwaites 544, mentioned by Berkeley and Broome under *Thelephora accumbens*, is referred by Bresadola (*loc. cit.*) to *Septobasidium Merrillii* Bres.

Hymenochaete ramealis Berk., Fungi of Ceylon, No. 611 = *Stereum rameale* Mass., Mon. Theleph., Pt. II, p.187 = *Septobasidium aligerum* Petch, *nom. nov.*, *non* = *Septobasidium alatum* Lloyd.

Corticium reticulatum B. & Br., Fungi of Ceylon, No. 628 = *Corticium Marescalchianum* Manc. and Sacc., Sylloge, VI, p. 633 = *Corticium flavovirens* Massee, Mon. Theleph., p. 154 = *Septobasidium reticulatum* (B. & Br.) Pat., Bull. Soc. Myc. France, XXIV (1908), p. 2.

Corticium suffultum B. & Br., Fungi of Ceylon, No. 651 = *Septobasidium leucostemon* Pat., Bull. Soc. Myc. France, XXXVI (1920), p. 175.

Corticium alopecinum B. & Br., Fungi of Ceylon, No. 631 = *Septobasidium alopecinum* (B. & Br.) Petch, *comb. nov.*

Corticium murinum B. & Br., Fungi of Ceylon, No. 635 = *Septobasidium murinum* (B. & Br.) Petch, *comb. nov.*

Lachnocladium rameale B. & Br. = *Septobasidium rameale* (B. & Br.) Petch, Ann. Bot., XXV (1911), p. 842.

Caesalpinia Bonduc L. and Caesalpinia bonducella Flem.

BY

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WITH ONE PLATE.

In 1857, W. Ferguson examined the specimens of Hermann's Musaeum Zeylanicum, and made notes on them which are now in the Peradeniya Library. With regard to Flora Zeylanica, No. 156, he wrote, "Ic. good, showing swelled three-seeded fruit. It is the round-seeded one that strikes fire." The specimen is *Caesalpinia bonducella* Fleming.

Ferguson had travelled widely through Ceylon, and had a remarkably good field knowledge of its Flora. It is to be observed that in this instance he identified the plant in question correctly, and, judging from his note, that he had been in the habit of identifying it by the shape of its seeds. Unfortunately, there is no specimen of *Caesalpinia Bonduc* among Hermann's Musaeum Zeylanicum specimens, and consequently it is not possible to ascertain Ferguson's idea of the shape of the seeds of that species. But evidently, for him, the species with globose seeds was *Caesalpinia bonducella*.

It appeared of interest to examine the descriptions of *Caesalpinia bonducella* and *Caesalpinia Bonduc* to see what characters had been relied upon by different authors for the separation of these two species, and whether this character, the shape of the seed, had been taken into consideration. In discussing these descriptions below, I have retained the names *Caesalpinia Bonduc* and *Caesalpinia bonducella* under which the two Asiatic plants have been recognised during the last hundred years. The confusion of the Linnean specimens was noted by Ferguson, and the facts were published independently by Trimen. Merrill considered the synonymy of the two species, but did not push his findings to their logical conclusion. It would seem that this is eminently a case to which the principle of *nomina conservanda* should be applied.

Baker, in Flora British India, stated that *Caesalpinia Bonduc* has ascending bracts, and leaves without stipules; and that it differs from *C. bonducella* in the absence of the reduced stipular pinnae, and in its

smaller, not squarrose bracts; he did not describe the seeds. According to the same authority, *C. bonducella* has stipules, oblong, obtuse, mucronate leaflets, squarrose bracts, and *oblong, lead-coloured seeds.*

Under *C. Bonduc*, Baker cited *C. Bonduc*, Roxb. Hort. Beng. 32, Fl. Ind. II. 362, DC. Prod. II. 480 ; *G. glabra* Miller Dict. No. 3. Under *C. bonducella*, he cited *C. bonducella*, Roxb. Fl. Ind. II. 357, Fleming in Asiatic Res. XI 159 ; *G. Bonduc* W. & A. Prod. 280, Dalz. and Gibs. Bombay Flora 79 (in part). Later botanists disagree with these citations. Gamble, Flora Presidency Madras, regards both W. & A. Prod. 280 and DC. Prod. II. 480 as including both species ; and Cooke, Flora Presidency Bombay, regards W. & A. Prod. 280 as being only in part *C. bonducella*, while he cites Dalz. & Gibs. Bombay Flora 79 as that species, without the qualifying " in part."

Roxburgh, in Flora Indica, stated that *Caesalpinia Bonduc* has oval, mucronate leaflets, and *C. bonducella*, ovate-oblong leaflets, reflexed bracts, and pinnatifid stipules. He did not describe the seeds. Under *C. bonducella*, Roxburgh remarked that plants reared from seed from the West Indies proved to be exactly the same, and that the seed is a powerful tonic ; while under *C. Bonduc* he stated that this species had been introduced into the Botanic Garden, Calcutta, from Sumatra, but had not flowered, though it had grown luxuriantly.

Under *C. bonducella*, Roxburgh cited Rumph, Amb. 5, t. 49, fig. 1, and Rheed. Mal. ,2, t. 22. Rheede's figure shows elliptic seeds, somewhat intermediate in character, but nearer *C. Bonduc*, stipules, scattered prickles, recurved bracts, and leaflets varying from obtuse to acute; he described the seeds as " oblongo-rotundo, cortice duro albocinereo venulisque nigris undulantibus striato." Rumph. Amb. 5, t. 49 fig. 1, shows acute leaflets, paired prickles on the rachis, a lax inflorescence with scarcely reflexed bracts, and foliaceous stipules ; he did not figure the seeds, but described them as " ex rotundo parum oblonga et ad latera compressa, cinerei coloris, quaedam vero caerulescunt et alia nigrescunt."

Rumphius Herb. Amb. 5, t. 48, which is taken as *Caesalpinia Bonduc*, shows oval-lanceolate leaflets, scattered prickles, no stipules, a lax inflorescence, and subglobose seeds. He described the seeds of this species as round, like marbles, and " Coloris pallide cinerei, glabra et splendentia circulis quibusdam subtilibus notata, et ad unam partem parum protuberantia, ubi et gilva macula notata sunt, qua siliquae fuere nexa ; horum quaedam perfecte sphaerica sunt, excepto illo prominente angulo, quaedam magis oblonga instar ovorum lacertae, quaedam cinerea penitus sunt, alia pallidiora, et albicantia." According to Ceylon experience, this description would cover the seeds of both species.

Miller, Dictionary, styled *Caesalpinia Bonduc*, the Yellow Bonduc, and stated that it had seeds about the size of marbles and of a yellowish colour. *C. bonducella* he named the Grey Bonduc, and described the seeds as ash-coloured, grey, commonly used as marbles by boys in the sugar colonies ; and again as ovate-globular, very smooth and shining, seeming as if they had very fine parallel annular clefts, but quite entire, of a livid lead colour, with a brown mark at the navel.

Miller repeated Sloane's record that the seeds of *Caesalpinia bonducella* are cast ashore on the North West coasts of Ireland and Scotland and are there called Molucca Beans. He also quoted Sloane's statement that there is no difference between *Caesalpinia bonducella* and *Caesalpinia Bonduc* except in the colour of the nut, which in the latter is yellowish, finely variegated with annular or interrupted saffron-coloured zones,; presumably this refers to Jamaican specimens.

Miller's second description of the seeds of *C. bonducella* is identical with that of Gaertner, De Fructibus, II (1791), p. 315, and the description of the seed of *C. Bonduc*, *ex* Sloane, is also the same as Gaertner's. The latter's specimens of seeds of *C. bonducella* were obtained from Miller. Gaertner figures the seeds of the two species the same shape, ovato-globose, but not round enough to be used as marbles.

Lunan, Hortus Jamaicensis, 1814, stated that *C. Bonduc* has yellow seeds like marbles, and ovate leaflets with single prickles on the mid-rib, while *C. bonducella* has grey seeds like marbles, and two opposite prickles below each pair of leaflets.

Returning to Eastern writers, we find that Gamble, in Flora Presidency Madras, describes *C. Bonduc* (*C. Jayabo*) as having elliptic-oblong acute leaves, and no stipules, and *C. bonducella* (*C. crista*) as having foliaceous stipules, and elliptic-oblong, obtuse, mucronate leaflets. He states that the seeds of both are *globose* and grey.

Cooke, Flora Presidency Bombay, does not record *C. Bonduc*, but describes *C. bonducella* as having elliptic-oblong, obtuse, strongly mucronate leaflets, stipules a pair of reduced pinnae each furnished with a long mucronate point, flowers in dense racemes, squarrose bracts, and *oblong, lead-coloured seeds.*

Haines, Botany of Bihar and Orissa, records *C. bonducella* (*C. crista*) only, and states that it has leaflets with obtuse, mucronate tips, and *large round seeds.* Both Cooke and Haines style *C. bonducella*, the Fever Nut.

In the Dictionary of the Economic Products of India, *Caesalpinia bonducella* is again given as the Fever Nut and as the Sinhalese Kumburu. It is also stated that "At the late Colonial and Indian Exhibition, a pale orange-coloured nut was shown by the West Indian Colonies as

obtained from a special cultivated form of this plant. This is not known in India, the nuts being all of a slaty olive-green." A Bangalore correspondent is cited for the information that the seeds are used as marbles. This work does not mention *C. Bonduc*.

Grisebach, Flora of the British West Indian Islands, included *Guilandina Bonduc*, stipules abortive, seeds yellow ; *Guil. bonducella*, stipules cut into large segments, seeds lead-coloured ; and *Guil. glabra* Mill., " seeds grey " (Duchass.).

Fawcett and Rendle, Flora of Jamaica, include *Caesalpinia Bonduc*, stipules wanting, seeds yellow, *subglobose* (with all Grisebach's names as synonyms); and *Caesalpinia bonducella*, stipules of two or three leaf-like segments, seeds pale greenish grey, *subglobose*.

It is evident from the descriptions that the principal difference between the two species is that *C. bonducella* has leafy stipules, while *C. Bonduc* has none.

As regards the other characters, *C. bonducella* has a dense inflorescence, with squarrose bracts, and *C. Bonduc* a more lax inflorescence with straighter bracts.

The leaflets of *C. bonducella* are ovato-oblong (Roxburgh), oblong, obtuse (Baker), elliptic-oblong, obtuse (Gamble, Cooke), obtuse (Haines); but variable in Rheede's figure, and acute in that of Rumphius. The leaflets of *C. Bonduc* are oval (Roxburgh), ovate (Lunan), elliptic-oblong, acute (Gamble), and oval-lanceolate in Rumphius's figure.

Lunan stated that *C. bonducella* has two opposite prickles below each pair of leaflets, while *C. Bonduc* has single prickles on the midrib (? the secondary rachis). Rumphius's figure shows prickles in irregular pairs on the main rachis of the former species, but on Rheede's figure they are scattered.

As regards the seeds, the descriptions differ rather widely. All West Indian writers state that the seeds of both species are the same shape but differ in colour, those of *C. Bonduc* being yellow, and those of *C. bonducella* grey. In India, Gamble states that the seeds of both are globose and grey ; Baker and Cooke state that the seeds of *C. bonducella* are oblong and lead-coloured, but Haines says that they are round. Rumphius stated that the seeds of *C. Bonduc* were variable, some round, some oblong, and those of *C. bonducella*, " ex rotundo parum oblonga," while Rheede described those of the latter as " oblongo-rotundo."

In Ceylon, the seeds of *C. Bonduc* are lead-coloured, shining, oblong-oval or narrow oval, not compressed, like the eggs of a lizard in shape. The hilum is at one end, is brown, and sometimes bears a minute projecting point, the remains of the funicle. The seeds are marked with fine, more or less parallel lines, concentric with the hilum ; under a high

magnification, some of these lines are seen to be raised ridges. The average weight per seed of twenty-eight seeds from Henaratgoda was 1·71 grams, the heaviest weighing 2·05 grams and the lightest 1·23 grams. The average weight per seed of fifty seeds from Kalutara was 1·75 grams, the heaviest weighing 2·25 grams and the lightest 1·18 grams.

The seeds of *C. bonducella* in Ceylon are grey and comparatively dull. Some may have an olive or yellowish olive tinge, but that indicates that they have been taken from unopened pods. In shape they are irregularly globose, slightly, or sometimes strongly, laterally compressed, and often with one or more flattened facets. The hilum is brown and does not project. A few seeds are ellipsoidal, but in these the hilum is situated on the long side of the ellipse, not terminally as in *C. Bonduc*. They are marked with fine, more or less parallel, dark lines, concentric with the hilum. These lines, on fresh specimens, appear as ridges when magnified. As the lines are concentric with the hilum, they run lengthwise on the ellipsoidal seeds. The average weight per seed of one hundred Ceylon seeds of *C. bonducella* was 2.16 grams.

Seeds of *C. bonducella* from Coimbatore and Madras are the same as the Ceylon seeds in colour and shape. The average weight per seed of one hundred seeds from Madras was 2·57 grams, the heaviest weighing 3·42 grams and the lightest 1·61 grams. The average weight per seed of forty seeds from Coimbatore was 2·44 grams.

As far as Ceylon is concerned it would appear that Ferguson was correct, and that *C. bonducella* can be distinguished from *C. Bonduc* by the shape of its seeds. Both in Ceylon and India, the seeds of *C. bonducella* are irregularly globose, and might be used as marbles with some sacrifice of accuracy. But the seeds of *C. Bonduc* answer rather to Gilbert's elliptical billiard balls.

The seeds sold in the Ceylon bazaars as Kumburu are invariably subglobose, and plants raised from bazaar seed have proved to be *C. bonducella*. Apparently, only the seed of *C. bonducella* is used medicinally in the East.

The leaflets of *C. bonducella* are typically elliptic-oblong, obtuse, those of *C. Bonduc* ovate, acute, sometimes acuminate. But though the general appearance of a plant of *C. bonducella* gives the impression that all the leaflets are elliptic-oblong, they are really variable, and some approach the leaflets of *C. Bonduc* in shape, as shown in Rheede's figure. Thus, when only part of a leaf is available the specimen may be misleading. In both species the leaves are strongly mucronate.

Caesalpinia bonducella, in the Ceylon specimens, has a pair of prickles on the secondary rachis below each pair of leaflets, as noted by Lunan. *C. Bonduc*, in Ceylon specimens, may have paired prickles or a single prickle in that position, but this feature is variable, and most of the pairs of leaflets have no accompanying prickles.

The leafy stipules of *C. bonducella* appear at first sight to constitute a sufficient distinguishing character. This, however, has evidently proved inadequate. When plants are grown from seed, no stipules are produced until after about a dozen leaves have appeared. That would not affect diagnosis in the majority of cases, as seedlings would not be collected. But as the plant matures and the stems become woody, the stipules fall off, and no clearly marked scar is left on the stem. This, in conjunction with the peculiar constitution of the flowers of *C. bonducella*, makes identification of fruiting specimens by means of the stipules frequently impossible.

As is well known, the flowers of *C. bonducella* are frequently male only, the pistil being rudimentary. When plants grown from seed first came into flower, all the flowers contained only rudimentary pistils, and this state continued for several months. After about six months, the inflorescences produced towards the ends of the rapidly-growing green shoots were still imperfect, but those developed on other shoots, possibly of slower growth, were perfect, and began to set fruits. In some of the latter instances, the stipules had been shed as soon as the fruits began to form. Thus, specimens collected from the periphery of the plant would bear inflorescences with imperfect flowers and leaves with stipules, while the fruiting specimens from deeper in the tangle might not bear stipules. This is the more likely to occur, since the fruits take about five months to ripen.

It is evident that if fruiting specimens, or specimens from old plants, are judged simply by the presence or absence of stipules, the identification may be incorrect. Of four sheets included under *C. Bonduc* in the Peradeniya herbarium, three are *C. bonducella*. None of these three bears any stipules. One specimen bears fruit only. The other two sheets are from one locality on the same date, and probably from the same plant. One of the latter is in fruit and shows the typical leaflets, prickles, and seeds of *C. bonducella* ; the other has the same leaflets, and a crowded inflorescence with squarrose bracts.

The flowers on one inflorescence of *C. bonducella* appear to be all of the same character, i.e., they are either all perfect or all imperfect. On the inflorescences which bear imperfect flowers, the flowers are more crowded and the bracts more conspicuous than on those which bear perfect flowers. The perfect flowers are larger, of a deeper yellow, and

have the red spots and streaks on the dorsal petal more pronounced, than the imperfect flowers. On the specimens under cultivation, it was possible to tell which inflorescences bore perfect flowers, when they were in bud, as the buds were larger, and darker owing to the greater development of the brown tomentum. On the imperfect buds, the tomentum was only slightly developed, and sometimes barely evident.

From the foregoing details, it would appear that the shape of the seeds is, in Ceylon, a valid distinguishing character between *C. Bonduc* and *C. bonducella*, but that the shape of the leaflets and the presence or absence of stipules may be unreliable. Further examination of living examples of these two species in other countries would seem desirable.

Fig. 1.—Seeds of *Caesalpinia Bonduc*, nat. size

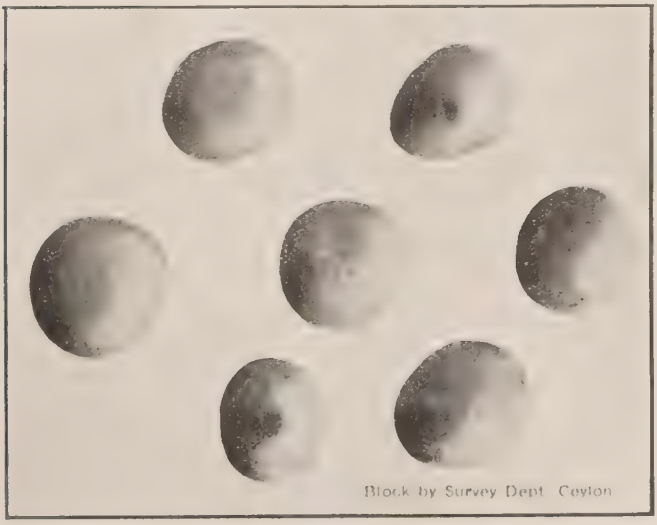

Fig. 2.—Seeds of *Caesalpinia bonducella*, nat. size

The Genus Chukrasia

BY

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Trimen (3) follows Hiern (1) in calling this genus Chickrassia, after its Bengali name Chickrassi, though it was named Chukrasia by Jussieu. Under *C. tabularis* A. Juss., Trimen has the following note,—"Our plant is the variety with the leaves silky-tomentose, which is *C. velutina* Roem., and is maintained as distinct from *C. tabularis* by Cas. D.C. in his monograph. I have only seen 4-merous flowers, but in Fl. B. Ind. the anthers are given as 10 and the ovary and capsule 3–celled, and in Wight and Beddome's figure the ovary is 5–celled." Specimens collected at Hakkinda recently differ from Trimen's description of the Ceylon plant. The chief points of difference between the Hakkinda specimens and the specimens (of which there are only two sheets in the Peradeniya Herbarium) from which Trimen made his description of the Ceylon plant are tabulated below. The former can at sight be distinguished, in that its leaves are glabrous while those of the latter are covered with a silky tomentum.

	Hakkinda Specimens.	*Trimen's Specimens.*
1.	Leaflets uniformly acute towards the apex which is distinctly cuspidate.	Leaflets abruptly and shortly acuminate.
2.	Leaflets glabrous.	Leaflets silky-tomentose.
3.	Flowers long-pedicelled (average length 5 mm.).	Flowers short-pedicelled (average length 2 mm.).
4.	Outer surface of sepals villose.	Outer surface of sepals tomentose.
5.	Petals membranous.	Petals fleshy.
6.	Stamen tube distinctly toothed.	Stamen tube neither toothed nor veined.
7.	Anthers 10, elliptic.	Anthers 8, ovate.

C. de Candolle (2) described both *C. tabularis* and *C. velutina* as having ten anthers each and placed the Ceylon plant under *C. velutina*. (Trimen is the only author who has mentioned this variation in the number

of anthers in the Ceylon specimens.) Trimen's specimens were from within a very small area of the Central Province, viz. from Deltota, Hanguranketa, and Kandy. Hakkinda is within this area and does not differ appreciably from any of the other three localities, either in climatic conditions or elevation. These differences in the characters of the Hakkinda plant are therefore not local and it is entitled to be regarded as a distinct species. The Hakkinda plant should be called *Chukrasia tabularis* Juss., while Trimen's plant (3) should be *C. velutina* Roem.

The descriptions given below are of the two Ceylon species of Chukrasia and do not include descriptions of the Indian plants.

Chukrasia A. Juss.

Large trees. Leaves imparipinnate, rachis 8–10 in. long, terete ; leaflets 10–20, alternate, entire, stalked, very unequal at the base. Inflorescence a terminal, or axillary, pyramidal panicle of pedicellate, hermaphrodite flowers. Calyx shallowly 5-lobed. Petals 5, free, contorted, linear-oblong, spreading. Stamens connate into a tube, which is slightly shorter than the petals, toothed or not. Ovary superior, 3–5–celled ; ovules numerous, superposed, in two rows. Stigma discoid. Fruit a woody, septifragal capsule. Seeds exalbuminous, rough, compressed, with a large slender wing.

1. *C. tabularis* A. Juss. Mem. Mel. p. 141.

Tree glabrous throughout. Leaves with 5–8 pairs of distinctly cuspidate leaflets. Panicles equal to or greater than half the length of the rachis. Flowers long-pedicelled. Calyx villous externally. Petals membranaceous. Stamen-tube distinctly toothed : anthers 10, elliptic.

Hakkinda. Fl. May.

2. *C. velutina* Roem. Syn. fasc. 1. p. 135 ; D.C., Mon. Phan., 1. (1877), p. 727.

Tree tomentose throughout. Leaves of 8–10 pairs of shortly acuminate silky-tomentose leaflets. Panicles tomentose, shorter than half the length of the rachis of the leaf. Flowers shortly pedicelled. Calyx tomentose. Petals fleshy. Stamen-tube not toothed. Anthers 8, ovate.

Deltota, Hanguranketa, Kandy. Fl. May.

REFERENCES

(1) Hiern, W. P. in Sir J. D. Hooker's Flora of British India, 1 (1875), 567.

(2) De Candolle, C. Monographiae Phanerogamarum, 1 (1877), p.726, 7.

(3) Trimen, H. Flora of Ceylon, 1 (1893), pp. 251, 2.

Clathrus crispatus Thwaites

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

Berkeley, in Hooker's London Journal of Botany, VI., pp. 479–514 (1847), recorded *Clathrus cancellatus* for Ceylon from specimens collected by Gardner, and the same species was recorded by Berkeley and Broome in Fungi of Ceylon, No. 700, from Thwaites' collection. Thwaites, however, had considered the Ceylon species distinct from the European *Clathrus cancellatus*, and had marked his specimens and the paintings which accompanied them *Clathrus crispatus*. The latter specimens, which are represented in the Peradeniya herbarium, were collected on Hantane in 1859, and there is also a specimen collected at Hakgala in 1881.

Fischer, in Neue Untersuch. Phalloideen, 1893, adopted Thwaites' unpublished name for this species. He had examined fragments of the Ceylon specimens from Hantane, which were in the Kew herbarium together with pieces from Myrong, Khasia, and Merida, Yucatan, doubtfully referred to *C. crispatus*. He stated that all the foregoing examples were in a fragmentary condition, but as far as could be determined they represented a distinct species intermediate between *Clathrus cancellatus* and *Clathrus crispus*. In agreement with *Clathrus crispus* the meshes of the net were rounded and decreased in size from the base upwards, while the branches appeared to be flat and thin and not so massive as those of *Clathrus cancellatus*. He could not distinguish on the meshes of the net the obliquely ridged margin which is characteristic of *Clathrus crispus*, and considered that the spore mass must be more limited to the inner side of the net than in the latter species. But better material was necessary, to decide whether it was really a good species. In Untersuch. Phalloideen, 1900, Fischer listed *Clathrus crispatus* among the insufficiently known species.

There are two paintings of this species in Herb. Peradeniya. One, labelled July 29, 1859, shows two unexpanded specimens, spherical,

brownish or yellowish grey, 7 cm. in diameter, marked above with hexagonal areas about 1·5 cm. across, and below with elongated polygonal areas which extend to the base. The mycelium consists of numerous, thick, white cords. The other painting is labelled "*Clathrus crispatus*, Hantane, elev. 4000 feet, August 1859," and represents the same two specimens, one of them now expanded. The net is broken into four parts and lies more or less flat. One part is apparently half the whole receptaculum, while each of the other parts consists of a basal arm and a small part of the net. The broken outspread receptaculum measures 24 cm. in diameter. The basal arms are six in number, and vary in length from 3 to 6 cms., and in breadth from 1·5 to 2 cms. The arms of the net are of the same breadth, and the oval meshes are only about 2 x 1·25 cms. The colour of the exterior is pinkish, with a red margin to the meshes, while that of the interior varies from pinkish at the base to deep red in the middle of the arms.

At the time my paper on the Phalloideae of Ceylon was published (Ann. Perad., IV., pp. 139–184), I had not seen expanded specimens of this species. "Eggs" had been gathered at Hakgala, but these did not develop further when brought to Peradeniya. These eggs were reticulated externally with furrows which divided the exterior into a series of close-set, flat-topped or rounded, polygonal tubercles. Their appearance was thus identical with that of the specimens obtained by Thwaites. This is the usual structure of the wall of the egg, and it apparently constitutes one point of difference between this species and *Clathrus cancellatus*. The furrows lie along the lines of attachment of the plates which traverse the internal gelatinous layer and extend to the bars of the net. A photograph of an egg was given in Ann. Perad., IV., Plate XIII.

This species, like *Aseroe rubra*, is not found at the elevation of Peradeniya (1600 ft.). Thwaites found it on Hantane, which is near Peradeniya, but about 2000 ft. higher. It has been collected on several occasions at Hakgala (5600 ft.), but always in a fragmentary condition. It is apparently not uncommon at an elevation of about 4000 ft., where it may occur during the rains on cultivated ground on tea estates; and in 1909–13, several examples were kindly sent me by Mr. G. Cameron, of Ythanside Estate, Kotagala. All expanded specimens were found in fragments. As it does not occur at Peradeniya, there have been no opportunities of observing it under natural conditions. A specimen, however, was sent me from Hakgala in the egg stage, and this expanded at Peradeniya, after being planted in a pot and covered by a bell jar. Photographs of this latter specimen were obtained and are reproduced herewith.

Plate XV (upper figure) shows the receptaculum, about two-thirds natural size, immediately after the rupture of the volva. Part of the volva is seen on the left, the inner side uppermost, and this shows clearly the polygonal arrangement of the white plates which traverse the translucent jelly. At this stage, the meshes of the net are comparatively small. It will be noted that although the expansion of the receptaculum has only just begun, it is already breaking up. The bars in the centre of the figure have broken across, disclosing the inner honeycomb structure, and another near the base is split half through.

The final stage of expansion is seen in the lower figure, which is one half natural size. The upper part of the receptaculum has separated completely from the remainder, and lies to the right. The pale upper surface of that fragment is the *outer* surface, the curvature having been reversed during expansion. The remainder shows the red inner surface, the bars of the net being covered internally by the dark gleba.

Thwaites' specimen was collected in the egg stage, and evidently broke on expansion. The same happened with the present specimen. Moreover, all examples seen in the field have been in fragments. Hence it would appear doubtful whether the receptaculum of this species ever expands into a perfect net.

The net is pale pink externally, becoming deeper pink on the sides of the meshes, and deep crimson on the inner face of the bars. The bars are up to 2 cm. in breadth and 1 cm. thick in the middle, while the openings (meshes) are small, rounded or slightly polygonal, 1·2–2·2 cm. diameter. In cross section the bars are flat externally, sometimes rounded on the inner side, but more usually truncate-triangular, i.e., the section has the shape of an isosceles triangle with the apex cut off, the base of the triangle being outermost. The inner face is flat or slightly rounded, and is covered with a network of crimson ridges, while the sloping sides of the bars are slightly fluted. The dark olive gleba is confined to the crimson ridged area on the inner side of the bars.

The bars are composed of large irregular chambers in one or two layers, but the arrangement of the chambers is irregular. The walls of these chambers are perforated by minute crowded openings on the outer surface, and by larger more scattered openings on the inner face of the bars. Internally, the chambers communicate by large openings in their lateral walls, to such an extent that in places there appears to be only a series of struts from side to side within the bar. It is probably because of this excessive perforation that perfect examples have not been observed.

The mycelium is white, and its cords are up to 4 mm. in diameter. The spores are greenish hyaline, oblong with rounded ends, 4–5 x 2 μ.

Clathrus crispatus Thwaites, ×⅔

Clathrus crispatus, ×½.

Additions to Ceylon Fungi. III

BY

T. Petch, B.A., B.Sc.

HYMENOMYCETAE

Mycena illuminans P. Henn. On an Areca stump, Katugastota, July 3, 1922; No. 6479.

In the available specimens, both surfaces of the pileus glowed in the dark with a greenish light. The stalk was not luminous. The following is the description of the Ceylon fungus.

Pileus up to 12 mm. diameter, broadly convex, or plane with a decurved margin, umbilicate in the centre, hyaline, greyish in the centre, closely plicato-striate, slightly viscid, fragile, margin crenate. Stalk 2 cm. high, 1·2 mm. diameter, curved, slightly attenuated upwards, slightly expanded at the base, sub-translucent, minutely pruinose. Gills numerous, crowded, broad in front, attenuated for some distance behind, free; cystidia elongated oval, or subcylindric, 32 x 12 μ, sometimes suddenly attenuated into a curved beak, up to 12 μ long, 2 μ diameter, acute at the apex. Spores white, oval, 6–7 x 4–5 μ.

The Ceylon fungus agrees in general shape with Holtermann's figures of *Mycena illuminans* from Java, but Holtermann does not show the cystidia. von Höhnel stated that the Javan fungus had globose spores 8–9·5 μ, and cystidia 24 x 10–12 μ, cylindric-oval, and covered with cylindrical papillae, 2–3 μ long, at the apex.

Hebeloma siennaecolor Petch, n. sp. Pileus up to 6 cm. diameter, broadly convex, then plane or depressed in centre, margin repand, brownish red, smooth; flesh thin, white. Stalk up to 5 cm. high, 1 cm. diameter, equal, slightly bulbous at the base, white, longitudinally striate, hollow. Gills at first white, becoming ochraceous, somewhat distant, rather narrow, sinuate, with a decurrent line. Spores yellow-brown, oval, slightly inequilateral, 5–7 x 3·5–4 μ. On the ground, Peradeniya, April 1915: specimen and painting, No. 4609.

Hebeloma trachysporum Petch, n. sp. Clustered. Pileus at first conical, margin inrolled, then broadly conico-campanulate, 6 cm. diameter, yellow, slightly viscid, shining when dry, the cuticle cracking into minute

red brown areolae ; when old, red brown, minutely granular, margin paler : flesh thick, yellow, becoming brown or red brown when old. Stalk up to 9 cm. long, 8 mm. diameter, rooting, at first pale yellow with red-brown dots and streaks, then red-brown, longitudinally streaked, pulverulent with scattered red-brown points, equal, or fistulose below, stuffed, yellow to red-brown internally. Gills pallid, then pale brown with a yellow edge, adnate with a strong decurrent tooth, broad (up to 7 mm.), attenuated outwards. No cystidia. Spores pale brown in mass, with a slight reddish tinge, yellow-brown by transmitted light, globose, 8–10 μ diameter, with large, irregular, flattened warts, up to 3 x 2 μ, sometimes arranged in lines and confluent. On a decaying palm stump, Peradeniya, July 11, 1909 : painting in Herb. Peradeniya.

Psalliota stadii Petch, n. sp. Pileus at first obtusely conico-campanulate, becoming broadly convex or plane, at first innately silky, shining, slightly viscid, the outer layer sometimes cracking into scales, white, slightly ochraceous in the centre, tinged purple when old, brittle, up to 6 cm. diameter ; flesh stout, white. Stalk stout, short, up to 3·5 cm. high, 1 cm. diameter, white or faintly yellowish, slightly innately fibrillose below, shining and silky striate above, with a central cavity stuffed with shining silky fibrils, or hollow, lined with silky fibrils ; partial veil stout, forming a descending curtain on the stem, no ring. Gills crowded, ventricose, or narrow and equal, free but close to the stem, pale purple brown, edge whitish ; spores purple brown, oblong-oval, 6 x 4μ. On the ground among grass, edible ; on the Golf Links, Peradeniya ; type specimen and painting, No. 6257. Near *Psalliota simulans* B. & Br., which differs in its more coloured pileus, arcuate gills, smaller spores, flesh changing colour when cut, etc.

Stropharia rostrata Petch, n. sp. Clustered. Pileus campanulate, up to 1·8 cm. diameter, with an abrupt, conical, obtuse umbo up to 2·5 mm. high, ashy, bay brown at the umbo, becoming bay brown elsewhere when sodden, slightly viscid when moist, margin feebly striate ; flesh thin, white, becoming brown and watery. Stalk up to 7·5 cm. high, 4 mm. diameter, straight or flexuose, pallid, becoming fuscous, longitudinally fibrillose, clothed up to the ring with scattered, minute, white scales, hollow ; ring soon disappearing. Gills adnate, or adnato-decurrent, attenuated outwards, crowded, pallid then pale purple. Spores in mass dark purple-brown, violet by transmitted light, narrow oval, smooth, 6–9 x 4 μ. Every part turning blue when bruised. On elephant dung, Hakgala, March 9th, 1922 ; No. 6381, with figure.

Panaeolus rubricaulis Petch, n. sp. Pileus conical, up to 1·4 cm. high, 1·8 cm. diameter below, blackish grey when moist, grey or brownish grey when dry, not viscid, smooth, or sometimes feebly reticulated in

the centre, atomate, margin pale, at first incurved, rarely appendiculate : flesh thin, fragile, dull brown when moist, white when dry. Stalk up to 10 cm. high, 2 mm. diameter, red-brown to purple-brown, equal, smooth, base white tomentose, apex powdered with white ; no ring. Gills ascending, rather distant, ventricose, broadly adnate, grey, then blackened by the spores, margin white. Spores broadly elliptic, papillate with a hyaline papilla at each end, or lemon-shaped, brownish black, 12–15 x 8–12 μ. Cystidia on the edge of the gills flask-shaped, 24μ high, 8 μ diameter below, 4 μ diameter at the apex, apex slightly thickened. On manured ground, Peradeniya, November 9, 1922, etc. ; type specimens and painting, No. 6566.

There is apparently a specimen of this species in Thwaites 746 of September, November 1868, in Herb. Peradeniya, the remaining specimens being *Panaeolus cyanascens*. The stalk is red-brown always, not white at first.

Fistulina hepatica (Huds.) Fr. On a decaying tree trunk, Pedrotala galla, September, 1923 ; No. 6668.

Polyporus caesius Schrad. Hakgala, September 1923 ; No. 6671.

Fomes melanodermus Pat. Peradeniya, October 1923 ; No. 6713.

Fomes mesoleucus Petch, n. sp. Applanate, sometimes arising from an expanded basal tubercle, convex, orbicular, margin obtuse, purple black or blackish brown, somewhat mottled with purple brown here and there, especially towards the margin, upper surface irregularly rugose, matt, pore surface white. Context white, compact, hard ; cuticle very thin ; pores, in section, drying pale brown, and thus differing in colour from the context. Pores minute, 0·1 mm. diameter, 6 mm. long. Spores hyaline, globose, 6–8 μ diameter. On a dead stump, Warriapolla, December 1923 ; No. 6716. Available specimens up to 15 x 7·5 cms., and 2·5 cm. thick.

Mesulius gelatinosus Petch, n. sp. Resupinate, sometimes with a narrow, free, thin, rigid, upper edge, definite, in irregular patches up to 3 cm. long, 2·5 cm. wide, pale yellow, becoming ochraceous in drying ; hymenium well developed, labyrinthoid, sterile areas becoming white tomentose when dry, subgelatinous ; basidia 4-spored, cylindric, slightly inflated above, 3 μ diameter ; paraphyses clavate, slender, 2·5 μ diameter above, 2 μ diameter below, sometimes spinulose. On a dead mango branch, Peradeniya, June 1922 ; No. 6468.

Hydnum vagans Petch, n. sp. Mycelium forming stout cords overrunning decaying twigs, etc.; free cords rounded, 1 mm. diameter, tomentose, orange-yellow, becoming deeper orange where attached, expanding into irregular, membranous, separable, orange yellow patches, which bear terete, acute, rather distant spines, 1 mm. long, of the same

colour. On tea prunings, Ratnapura, August 1923 ; No. 6633. Similar in habit to *Poria rubrochorda* Petch, but differing in colour.

Corticium pervagum Petch, n. sp. Parasitic ; mycelium of stout, regular, septate, hyaline hyphae, 4–6 μ diameter, over-running and killing leaves and twigs ; hymenium forming diffuse, white, continuous, separable, powdery patches on leaves or stems ; basidia solitary or in groups on the basal hyphae, or lateral and terminal on short erect branches, sessile, pyriform, often transversely septate, 16 x 8 μ ; sterigmata tapering, 8 μ long ; spores ellipsoidal, somewhat inequilateral, hyaline, 5–8 x 3–5 μ. On *Erythroxylon coca* L., Peradeniya ; type, No. 6609.

Corticium penicillatum Petch, n. sp. Mycelium white, hypophyllous, spreading in flat strands up to 1 mm. broad, which divide at short intervals into a fan of radiating branches, one of which continues as the main strand, ultimately united by a thin film into a continuous sheet on which the basidia are developed. Hymenium white, almost continuous, forming a rather compact layer, 40 μ thick ; basidia at first lateral, then clustered, on short erect hyphae, pyriform or obconic or narrow-oval, 8–12 x 4–6 μ, four-spored ; sterigmata short, cylindric, 2 μ long ; spores hyaline, oval and inequilateral, or broadly cymbiform, 4–6 x 2·5–4 μ. On leaves of *Cocos nucifera* L., New Guinea, March 1924 ; parasitic.

Corticium invisum Petch, n. sp. Parasitic ; mycelium of hyaline; regular, septate hyphae, 4–6 μ diameter, over-running and killing leaves, and twigs of living plants ; hymenium forming thin, white, powdery patches, at first reticulated, ultimately continuous, usually on uninjured leaves ; basidia clustered, subglobose, 8–9 μ diameter, or ovoid, 9 x 7 μ sterigmata stout, attenuated above, up to 6 μ long, 1·5 μ diameter ; spores ellipsoidal, adherent, smooth, hyaline, 5–6 x 3–4 μ. On Tea, on which it causes the disease known as Black Rot in Ceylon ; also on *Oxyanthus tubiflorus* DC., *Hemidesmus indicus* Br., *Calophyllum Burmanni* Wight, and *Vernonia scariosa* Arn., Ceylon. Spores described from specimen on *Oxyanthus*, Henaratgoda, May 26th, 1917 ; No. 5332.

Heterochaete fimbriata Petch, n. sp. Resupinate, determinate, circular, about 1 cm. diameter, or confluent in larger patches, livid grey when moist, livid brown when dry, subtranslucent, with scattered white points ; margin stout, furnished with somewhat distant, white, conical, fascicles of hyphae, up to 0·5 mm. long, decumbent on the substratum ; 0·5 mm. thick, internally subtranslucent, tough, compact, horny when dry, basal layer yellow-brown, hymenium pale brown ; processes cylindric, or slightly inflated above 55–66 μ high, up to 30 μ diameter, encrusted, especially at the apex, with irregularly globose masses of calcium

oxalate ; spores hyaline, oblong-oval, 8–10 x 3 μ. On wood, Peradeniya, November 1913 ; No. 3838.

Sebacina rufochracea v. Hohnel in litt., n. sp. Reddish ochraceous, effused, adnate, waxy ; margin white or yellowish, at first adnate, indeterminate, byssoid, recurving when old and revealing the brown glabrous under surface ; thickness up to 0·25 mm., sub-hymenial layer translucent, yellow-brown to red-brown, compact, followed by a loose hyaline tissue containing quantities of granules of calcium oxalate, and a compact yellow-brown basal layer ; basidia oval, 10 x 8 μ ; sterigmata narrow flask-shaped, up to 6 μ long ; spores hyaline, cylindric, curved, sometimes guttulate, 14–15 x 7 μ. On dead *Hevea brasiliensis*, Mariawatte, November 12, 1909 ; No. 3007.

Uredinaceae

Phragmidium subcorticium (Schrank.) Wint. On *Rosa*, cult., 1920 ; No. 6309.

Phycomycetae

Empusa apiculata Thaxt. On a fly and on a wasp, Vavuniya, Dec. 1923 ; coll. G.M. Henry, det. Thaxter.

Pyrenomycetae

Meliola calostroma (Desm.) v. H. On leaves of *Rubus moluccanus* L., Haputale, June 1917 (No. 5307) ; ditto, Hakgala, March 1922 (No. 6402) ; on leaves of *Rubus ellipticus* Sm., Hakgala, March 1922 (No. 6403).

Guignardia Opuntiae Petch, n. sp. Perithecia about 0·2 mm. diameter, gregarious, crowded, immersed, prominent, black ; asci clavate, 65 x 10 μ, spores biseriate ; paraphyses linear ; spores hyaline, continuous, cymbiform, ends obtuse, 15–20 x 4–5 μ. On *Opuntia Dillenii* Haw., Vavuniya, November 1915 ; No. 4786a.

Glomerella Gossypii Edgerton. On cotton, Nalande, April 1924.

Desmotascus Cinnamomi Petch, n. sp. Perithecia gregarious, up to 0·2 mm. diameter, immersed in the cortex, raising the epidermis in minute pulvinate elevations ; asci clavate, thick-walled above, 60–80 x 14–20 μ, embedded in hyaline tissue ; spores hyaline, continuous, lozenge-shaped, ends obtuse, 18–24 x 7–9 μ. On stems of *Cinnamomum zeylanicum* Bl., Southern Province, Ceylon, July 1922 ; No. 6526.

Wallrothiella episphaeria n. sp. Conidial stroma up to 5 mm. diameter, white, circular, thin, up to 0·3 mm. thick, plane, or elevated in the centre, of loosely intertwined hyphae 1–2 μ diameter, bearing

conidia laterally, sometimes with a palisade layer of erect basidia, up to 24 μ high, at the margin ; conidia hyaline, oval, ends acute, 3·5–5·5 x 2–3 μ. Perithecia crowded on the old conidial stroma in a continuous layer, adherent laterally but readily separable, at different depths, oval or pyriform, up to 0·2 mm. high, 0·12 mm. diameter, apex obtuse and slightly papillate, wall parenchymatous, black or greenish black ; asci clavate, attenuated below when mature, 32–42 x 4–5 μ, eight or sixteen-spored; spores oval or oblong-oval, ends obtuse, 3–6 x 1·5–2 μ, sometimes globose, 2 μ diameter. Parasitic on *Aglaospora aculeata* on *Camellia theifera*, Blackwood, Haputale, June 1924 ; No. 6779.

Botryosphaeria theicola Petch, n. sp. Stromata immersed, oval or circular, up to 0·6 x 0·4 mm., parenchymatous, black ; loculi irregularly globose, 120 μ diameter ; asci clavate, scarcely pedicellate, eight-spored, spores biseriate above, uniseriate below, 70 x 16 μ ; paraphyses numerous, linear, diffluent ; spores hyaline, oval, 15–20 x 7–9 μ. On branches of *Camellia theifera* Dyer, Mahawale, 1918 ; No. 5739.

Botryosphaeria microspora Petch, n. sp. Stromata superficial, pulvinate, up to 2 mm. diameter, 0·75 mm. high, at first covered by a greyish white or purple grey tomentose film, becoming black, rough with close-set obtuse perithecia ; perithecia black, conoid, apex obtuse, 0·16 mm. high, 0·12 mm. diameter, embedded in the stroma for about one-third their height or rarely totally immersed, smooth, or with a few, rigid, spreading setae ; setae up to 50 μ high, 6 μ diameter, cylindric, septate, apex obtuse ; perithecial wall parenchymatous, thick, blackish brown in section, greenish above by transmitted light ; stroma internally soft, blackish brown, rather loose ; asci narrow-clavate, 30 x 5 μ, soon diffluent, eight-spored, spores uniseriate below, biseriate above ; spores oval or oblong-oval or sub-globose, hyaline, minutely warted, 2.5–6 x 2–3 μ, sometimes spuriously one septate. On old stems of tea, *Camellia theifera* Dyer, Diyagama, January 1924 ; No. 6730.

Botryosphaeria Erythrinae Petch, n. sp. Stromata subepidermal, oval or circular, about 1 mm. diameter, gregarious, united by loose hyphae in long linear patches, black, parenchymatous, ostiola not projecting ; loculi crowded, up to 0·25 mm. diameter ; asci 80 x 16 μ ; paraphyses filiform ; spores hyaline, continuous, lanceolate or narrow oval, ends obtuse, 18–24 x 5–6 μ. Some loculi are conidial, and contain Macrophoma spores, similar to the ascospores, 20–28 x 5 μ. On stems of *Erythrina lithosperma* Bl., Carolina, May 1918 ; No. 5718.

Anthostomella palmarum Petch, n. sp. Perithecia black, immersed, globose or laterally oval, 0·1–0·3 mm. diameter, scattered, or clustered in small groups and sometimes confluent ; wall thick, parenchymatous ;

ostiolum conical, not projecting ; asci eight-spored, cylindrico-clavate, wall thin, 100 x 12 μ ; paraphyses numerous, diffluent ; spores ellipsoid or oval, biconvex, black, opaque, with a narrow pale line along the edge, 12–15 x 7–10 μ. On decaying spathe of *Cocos nucifera* L., Atale, June 1922 ; No. 6476.

Sordaria caerulea Petch. n. sp. Perithecia scattered, globose, 0·3 mm. diameter, totally immersed in a thin byssoid stroma which is at first bright blue, becoming black when dry ; ostiolum conical, prominent when dry ; wall membranous, violet by transmitted light, as are also the hyphae of the stroma ; asci cylindrico-clavate or fusoid, long-pedicelled, apex truncate, 180 x 12 μ, eight-spored ; spores at first hyaline, cylindric, sigmoidly curved, 40 x 4 μ, becoming fuscous, oval, inequilateral, 14–16 x 6–8 μ, with a basal hyaline appendage. On elephant dung, Hakgala, March 1922 ; No. 6376.

Mycosphaerella citrullina (C. O. Sm.) Gros. On *Luffa acutangula* Roxb., Peradeniya, August 1921 ; No. 6290.

Mycosphaerella Caricae Syd. On *Carica papaya* L., March 1920 ; No. 6183.

Mycosphaerella Camelliae Petch, n. sp. Perithecia hypophyllous, gregarious, prominent, about 160 μ diameter ; wall parenchymatous, fuscous ; ostiolum black ; asci thick-walled, attenuated upwards, 32 x 6 μ ; paraphyses wanting ; spores hyaline, narrow-oval or fusoid, medially one-septate, not constricted, ends acute, 6–9 x 1·5–2 μ. On leaves of *Camellia theifera* Dyer, with *Phyllosticta Theae* Spesch., Concordia, October 31, 1922 ; No. 6554. Apparently different from *Mycosphaerella Theae* Hara and *Mycosphaerella Ikedai* Hara.

Didymosphaeria Theae Petch n. sp. Perithecia immersed, 0·4 mm. diameter ; wall thin, parenchymatous, purplish ; asci cylindric, shortly pedicellate, eight-spored, spores uniseriate or slightly obliquely uniseriate, 100–110 x 8–9 μ ; paraphyses filiform ; spores oblong-oval, straight or slightly curved, equally one-septate, not constricted, olivaceous, 14–17 x 6–7 μ. On branches of *Camellia theifera* Dyer, Golinda, August 1918 ; No. 5791.

Leptosphaeria tornatospora Petch, n. sp. Perithecia scattered, immersed, becoming prominent, 150 μ diameter ; ostiolum 25 μ diameter, not projecting ; asci clavate, 80 x 12 μ, eight-spored, spores biseriate ; paraphyses numerous, linear ; spores brown, cylindric, five-septate, constricted at the septa, one cell often inflated, one end rounded, the other conoid, 16–24 x 5–6 μ. On dead twigs of tea (*Camellia theifera* Dyer), Keppoch, January 1923 ; No. 6572.

Actinodothis Piperis Syd. On leaves of Piper sp., Hakgala, February 1923 ; No. 6616.

Microdothella Theae Petch, n. sp. Stromata subcuticular, oval, up to 0.5 mm. long, 0.4 mm. broad, about 0.1 mm. high, flattened pulvinate, black, rugose, usually unilocular ; cover black, thin, breaking up irregularly in the centre, but radial towards the margin ; ostiolum circular, 30 μ diameter, not projecting ; stroma limited below by a very thin fuscous layer ; asci ovate or cylindric, with a short stout foot, thick-walled, spores biseriate, 50–70 x 20–24 μ; paraphyses united into a tissue between the asci, with septate, irregularly jointed, free tips, up to 3 μ diameter ; spores oval or ovate, hyaline, continuous, contents granular, 16–18 x 9–12 μ. On twigs of tea, *Camellia theifera* Dyer, Keppoch, January 1923 ; No. 6574.

Dermatodothis zeylanica Syd. On leaves of *Symplocos elegans* Thw., Hakgala, April 1917, No. 5232 ; on *Symplocos obtusa* Wall., Hakgala, March 1922, No. 6404, etc. ; on *Symplocos latiflora* Clarke, Hakgala, April 1919, No. 6005.

Rosenscheldiella Eugeniae Petch, n. sp. Spots circular, purple, up to 3 mm. diameter. Stroma thin, parenchymatous, fuscous, large-celled, cells more or less in vertical rows, situated between the epidermis and the mesophyll, base flat ; loculi erumpent, usually single, sometimes fused laterally, conoid or subglobose, 130–160 μ high, 100–160 μ diameter, black, rugose, cavity oval, about 100 μ high, 80 μ diameter ; asci obclavate, 72–76 x 13 μ, with a short foot ; no paraphyses ; spores hyaline, narrow cymbiform or narrow fusoid, one septate, ends obtuse, 24–32 x 4 μ. On leaves of *Eugenia subavenis* Duth., Hakgala, February 1923 ; No. 6615.

Lasionectria dothideicola Petch, n. sp. Perithecia gregarious or clustered, globose, up to 150 μ diameter, red-brown, collapsing, dark yellow brown by transmitted light, bearing a few, stout, yellow brown to blackish brown, rigid, thick-walled setae, 26–65 x 7 μ, at the apex ; ostiolum not elevated ; asci four or eight-spored, from 28 x 8 μ to 46 x 16 μ; spores oblong-oval or fusoid, one-septate, hyaline, 14–20 x 3–4 μ. On lax byssoid patches which bear Fusarium conidia, three-septate, curved, 36–46 x 2·5 μ, in pink masses. Parasitic on *Phyllachora hibisci* Rehm on *Hibiscus tiliaceus* L., Anuradhapura, March 1922 ; No. 6534.

Hypocrea Bambusae v. Höhnel, Sitzungsber. d. Akad. Wiss. Wien, M. n. K., Abt. I., Bd. 129, p. 152 (1920). Stromata superficial, scattered or gregarious, at first globose, then somewhat flattened, with a strongly contracted base, white, then yellow, sordid red-brown when mature, with a matt, almost smooth surface, up to 1·3 mm. diameter,

internally yellow, fleshy, cortex pale yellow-brown. Perithecia ovate-pyriform, conical above, 120 μ diameter, 200–250 μ high ; ostiolum 28 μ diameter, not or only slightly projecting ; paraphyses scanty, slender, not diffluent ; asci cylindric, shortly stalked and attenuated below, 60–70 x 3 μ, apex not blue with iodine ; part-spores hyaline, shortly globoso-cylindric, guttulate, 2.5–3.2 x 2.5–3 μ. On bamboo, Peradeniya, 1907, coll. von Höhnel. If the part-spores are smooth, this species differs from those previously described from Ceylon.

Hypocrea cincta Petch, n. sp. Stromata dark red-brown or purple-brown, circular, subdiscoid, up to 1 cm. diameter, 3 mm. thick, upper surface plane or convex, sides rounded, attached over two-thirds the base, fleshy when fresh ; when dry, hard, minutely verrucose, internally purplish white, contracting so that the sides slope inwards and the perithecial layer extends beyond the lower part of the stroma and is demarcated by a furrow; perithecia in a single layer, globose, 0·25–0·3 mm. diameter, or laterally oval, 0·3 x 0·25 mm., wall yellow-brown ; asci 90 x 4 μ ; spores green or blackish green, dark green in mass, globose, 3·5–4 μ, or cuboid, 5 x 3·5 μ, minutely verrucose. On dead wood, Hakgala, March 1922 ; No. 6373.

Begins as a white, pulvinate, tomentose stroma, which becomes discoid and turns red-brown from the centre outwards, the margin and sides remaining white for some time. Probably the species which Berkeley and Broome referred to *Hypocrea rufa* from Ceylon.

Trichopeltula Hedycaryae Theiss. On leaves of *Scolopia crassipes* Clos. (No. 6396) and *Cinnamomum ovalifolium* Wight (No. 6400), Hakgala, February, 1922.

Acrospermum minutum P. Henn. On leaves of an undetermined jungle tree, Gonakelle, April 1924 ; No. 6762.

The specimens are larger, 1·8 mm. high, than given by Hennings (0·5 mm.).

Discomycetae

Niptera epiphytica Petch, n. sp. Generally hypophyllous, superficial, sessile, without evident stroma or on a thin, white mat of hyphae, yellow or orange yellow, centrally attached, up to 0·8 mm. diameter, 0·25 mm. high, disc flat or slightly concave, externally smooth ; asci clavate, thick-walled, 50 x 10 μ, apex not blue with iodine ; spores oblong-oval, ends obtuse, one-septate, not constricted, hyaline, 5–8 x 1·5–2 μ; paraphyses simple, 1·5 μ diameter, expanding above into an oval head, 8 x 5 μ. On living leaves of *Psychotria*, *Sarcococca*, *Murraya*, etc., which it does not injure, Hakgala ; type on *Psychotria*, Hakgala, March 1922.

Gorgoniceps marginata Petch, n. sp. Superficial, attached by a slight weft of white, radiating hyphae, sessile, urceolate, with a broad spreading margin ; height 0·3 mm., total diameter 0·5 mm., diameter below the rim, 0·3 mm. ; disc red-brown ; rim 0·15 mm. broad, white, pruinose with masses of calcium oxalate, convex ; externally red-brown, slightly white pruinose ; wall red-brown, 0·025 mm. thick, of parallel hyphae ; asci cylindric, 130 x 6–8 μ, apex thickened and sometimes with a cylindrical pore extending nearly to the apex, apex not blue with iodine ; paraphyses numerous, linear ; spores linear, as long as the ascus, septate, 1·2 μ diameter. On living leaves of *Hedyotis Lessertiana* Arn., Hakgala, January 1914.

Stictis emarginata Cke. & Massee. On leaves of *Eucalyptus robusta* Sm., Diyagama, August 1922 ; No. 6493.

Patellaria purpurea Petch, n. sp. Sessile, broadly concave, up to 2 mm. diameter, margin irregular, incurved ; at first dark reddish purple, becoming purple-black, internally greenish yellow ; outer layer of wall about 0·1 mm. thick, opaque, crumbly, followed by a hyaline layer, 0·05 mm. thick ; mass of asci greenish yellow, disc opaque in section ; asci cylindrico-clavate, 220 x 10 μ, apex blue with iodine ; paraphyses fused above ; spores hyaline, narrow oval, 3–4 septate, thick-walled, not constricted externally, the loculi strongly constricted internally, septa thin, 16–24 x 5–8 μ. On dead twigs of *Acacia melanoxylon* R. Br., Hakgala, March 1922 ; No. 6525.

Atichia Millardeti Rac. On *Cinnamomum Loureiri* Nees (No.6385), *Eurya japonica* Thunb. (No. 6386), *Scolopia crassipes* Clos. (No. 6387), Hakgala, February-March, 1922.

Endogone nuda Petch, n. sp. White, pulvinate, up to 1 cm. diameter, 4 mm. high, tomentose, without definite cortex ; hyphae 8 μ diameter, expanding to 20 μ below the chlamydospores ; chlamydospores globose, 90–160 μ diameter, or pyriform, up to 170 x 150 μ, wall 5–12 μ thick. Dry specimens are yellowish white, with an outer layer of hyphae and immature chlamydospores, 0·25 mm. thick ; internally granular, mottled, chlamydospores sordid yellow-brown, separated by pale yellow hyphae ; no central cavity. On matted rootlets at the margins of streams in the jungle, Hakgala, February 1923 ; No. 6598.

Sclerocystis alba Petch, n. sp. Stromata white, externally matted tomentose, hard, laterally ovoid, up to 1 mm. long, 0·8 mm. broad, 0·6 mm. high, aggregated and fused together in pulvinate masses ; internally white, with scattered red-brown asci ; hyphae of stroma hyaline or faintly yellowish, thick-walled, much branched, 8–16 μ diameter ; asci yellow-brown (by transmitted light), thick-walled (wall 6–8 μ thick),

globose, 80–88 μ diameter, or broadly ellipsoidal, 72–95 x 64–80 μ. On the ground among dead leaves, Hakgala, February 1923 ; No. 6600.

DEUTEROMYCETAE

Phyllosticta Theobromae d'Alm. & Cam. On *Theobroma cacao* L., Peradeniya, September, 1922; No. 6544.

Phyllosticta Theae Spesch. On *Camellia theifera* Dyer, Concordia, October 1922, No. 6555: Diyanila Kele, January 1923, No. 6573.

Phyllosticta Carica-papayae Allesch. On *Carica Papaya* L., Kandy, May 1924.

Phoma glumarum Ell. & Tr. On *Oryza sativa* L., Peradeniya, March 1920: No. 6185.

Plenophysa adiposa Petch, n. sp. Superficial, hemispherical, or convex, circular or oval in plan, up to 4 mm. diameter, dark purple brown, with a dull matt surface, glabrous, becoming lenticular, wrinkled, black, sometimes with a narrow, white, byssoid hypothallus, up to 0·1 mm. wide; internally blackish in mass, soft, viscid, subtranslucent, by transmitted light yellowish white with a thin outer brown cortex; cortex amorphous, reddish brown to black, with a few collapsed spores; basal layer thin, of hyaline hyphae 2 μ diameter; hypothallus consisting of a hyaline basal membrane containing a network of fine hyphae, 1–2 μ diameter, with a superficial layer of similar hyphae, loose and bearing globose hyaline conidia, 2–3 μ diameter, laterally; interior a mass of cohering hyaline, thin or thick-walled spores, oval, 6–10 x 4–6 μ, or globose, 7 μ diameter, with a few hyaline hyphae, 1–3 μ diameter, on which the spores are borne laterally, and large crystalloids of calcium oxalate up to 64 x 50 μ, which frequently include spores. The spores are united by a fatty (?) substance which dissolves in chloroform. Frequent at Hakgala on leaves of *Sarcococca pruniformis* Lindl., *Psychotria* sp., *Microtropis Wallichiana* Wight, etc.; also from Travancore, Nov. 8, 1908.

Plenophysa nitida Petch, n. sp. Superficial, oval in plan, up to 0·75 mm. long, 0·5 mm. wide, pulvinate or sub-turbanshaped, up to 0·4 mm. high, black, smooth, shining, even or slightly lacunose above; wall slightly brittle, 0·1 mm. thick, opaque, containing here and there brown hyphae 4 μ diameter, visible after treatment with caustic potash, and lined with brownish to hyaline, thick-walled hyphae 2 μ diameter; internal mass brown, somewhat loose and shrinking from the wall when dry, consisting of hyaline, continuous, oblong-oval spores, 2–3 x 1 μ, borne laterally on hyaline hyphae, 1 μ diameter, irregularly interwoven. On leaves of *Borassus flabellifer* L., Peradeniya, June 1913; No. 3664.

Phomopsis Theae Petch, n. sp. Pycnidia immersed, lenticular, oval in plan, up to 0·4 mm. long, 0·25 mm. broad; wall black, parenchymatous; ostiolum oval, 40 x 25 μ; A conidia narrow-oval or lanceolate, acute at one end, 6–8 x 1·5–2 μ; B conidia linear, flexuose or strongly hooked, 18–24 x 0·75 μ. On twigs of *Camellia theifera* Dyer, Keppoch, January 1923; No. 6587.

Macrophoma Theae Spesch. On leaves of tea, *Camellia theifera* Dyer, Dalkeith, June 1923; No. 6628.

Dothiorella Anonae Petch, n. sp. Stromata subepidermal, black, flattened pulvinate, about 0·3 x 0·2 mm., parenchymatous; loculi circular or oval in plan, up to 150 μ diameter; conidia hyaline, continuous, narrow oval, sometimes inequilateral, or subfusoid, ends usually obtuse, 18–22 x 5 μ. On twigs of *Anona Cherimolia* Mill., Hakgala, February 1923, raising and cracking the epidermis, ultimately falling out; No. 6604.

Cytospora Theae Petch, n. sp. Pycnidia immersed, circular or irregularly oval, 0·2–0·4 mm. diameter, usually clustered, black, simple or incompletely chambered; wall thin, parenchymatous; spores hyaline, oblong-oval, 3–5 x 1·5 μ; basidia variable, usually short, some simple, up to 24 μ long, a few branched, up to 32 μ long. On stems of *Camellia theifera* Dyer, Golinda, August 1918; No. 5789.

Coniothyrium Theae Petch, n. sp. Pycnidia amphigenous, minute, 50–60 μ diameter, black, erumpent, wall parenchymatous; ostiolum small, 5 μ diameter, furnished with periphyses; spores oval, pale fuscous, 2–3·5 x 1·5–2 μ. On leaves of *Camellia theifera* Dyer, with *Macrophoma Theae* Spesch., Dalkeith, June 1923; No. 6628.

Ascochyta Theae Hara. On *Camellia theifera* Dyer, Hemingford, April 1922; No. 6409.

Ascochyta rosicola Sacc. On *Rosa* cult., Peradeniya, October 1919; No. 6127.

Hendersonia confluens Petch, n. sp. Pycnidia 0·1–0·15 mm. diameter, erumpent, black, rugose, conoid, ostiolate, confluent or crowded on a black stroma in flat or flattened pulvinate groups up to 5 mm. diameter; wall parenchymatous, thick; basidia about 12 μ long; spores oval, two-septate, the middle cell fuscous or pale brown, the terminal cells hyaline and collapsing, 10–13 x 4–5 μ. On stems of *Erythrina lithosperma* Bl., Yataderia, June 1922; No. 6471.

Hendersonia macrospora Petch, n. sp. Pycnidia immersed, black, globose, 0·2–0.4 mm. diameter, usually clustered; basidia 8–16 μ long; spores oblongo-fusoid, thin-walled, three to five-septate, ends obtuse, hyaline then pale brown, 30–40 x 7–8 μ. On branches of *Camellia theifera* Dyer, Golinda, August 1918; No. 5790.

Hendersonina Sacchari Butler. On *Saccharum officinarum* L., Peradeniya, June 1921 ; No. 6269.

Septoria Lycopersici Speg. On *Lycopersicum esculentum* Mill., Peradeniya, January 1921 ; No. 6239.

Leptothyrium Theae Petch, n. sp. Pycnidia immersed, black, oval, up to 0·35 mm. long, 0·1–0·2 mm. broad, wall parenchymatous, opening by a longitudinal slit ; basidia narrow flask-shaped, 6–12 μ long , spores narrow-oval or subfusoid, hyaline, continuous, sometimes spuriously one-septate, ends usually acute, 5–8 x 1·5–2 μ. On stems of *Camellia theifera* Dyer, Hatnagalla, September 1917 ; No. 5357.

Gloeosporium piperatum Ell. & Ev. On Chillies (*Capsicum*), Peradeniya, May 1923 ; No. 6617.

Gloeosporium Opuntiae Ell. & Ev. On *Opuntia Dillenii* Haw., Vavuniya, Nov. 1915 ; No. 4786.

Colletotrichum nigrum E. & H. On Chillies (*Capsicum*), Peradeniya, May 1923 ; No. 6618.

Colletotrichum brachytrichum Delacr. On leaves of *Theobroma cacao* L., Pallekelle, April 1922 ; No. 6391.

Colletotrichum Ricini Petch, n. sp. Acervuli erumpent, flattened pulvinate, up to 0·3 mm. diameter, or confluent in large masses, pale brown ; conidia cylindric, ends obtuse, straight or slightly curved, 14–20 x 3·5–5 μ ; setae dark brown, straight or slightly flexuose, obscurely septate, apex subacute, base not inflated, 70–120 x 4–5 μ. On stems of *Ricinus communis* L., Peradeniya, November 1913 ; No. 3903.

Colletotrichum Dracaenae Petch, n. sp. Amphigenous, chiefly epiphyllous ; acervuli at first immersed, black, then erumpent, pale brown, oval, up to 0·3 x 0.12 mm.; spores hyaline, cylindric, ends rounded, 16–20 x 3·5–4 μ ; setae tardily developed, dark brown, obtuse, obscurely septate, often flexuose, strongly curved, not inflated below, 32–80 x 3–4 μ. On leaves of *Dracaena Sanderiana*, causing large, dark brown patches, Peradeniya, May 1924 ; No. 6775.

Colletotrichum Cordylines Pollacci has setae 124 x 7–8 μ. No spore measurement was given, but the spores are said to be " subaequilongis." If the latter term means equal in length to the setae, it is clearly a different species.

Melanconium palmarum Cooke. On *Cocos nucifera* L., Peradeniya, November 1921 ; No. 6354.

Pestalozzia Theobromae Petch, n. sp. Spots irregular, more or less orbicular, dark brown to blackish brown, faintly zoned, surrounded

by a narrow, pale green border ; acervuli epiphyllous, circular, 0·15 mm. diameter, or elongated, 0·3 x 0·15 mm. ; spores fusoid, four-septate, with three central coloured cells, triciliate, 15–20 x 5–7 μ (without pedicel or cilia) ; coloured cells 12–16 μ long ; pedicel about 4 μ long ; cilia short, up to 12 μ long. On leaves of *Theobroma cacao* L., Pallekelle, April 1922 ; No. 6392.

Pestalozzia disseminata Thuem. On leaves of *Eucalyptus* sp., Bunyan, December 28, 1921 ; No. 6451. Spots grey ; acervuli amphigenous, chiefly hypophyllous ; spores (without pedicel or cilia) 21–26 x 4–7 μ ; three coloured cells, 15–17 × 5–7 μ ; basal hyaline cell, 4–6 μ ; apical hyaline cell, 3–4 μ ; cilia 8–16 μ long ; pedicel, 4–6 μ long.

Pestalozzia Piperis Petch, n. sp. Spots large, orbicular, white or grey, with a narrow black margin ; acervuli amphigenous, chiefly epiphyllous, gregarious, towards the margin of the spot, black, circular, 0·2 mm. diam., lenticular ; spores fusoid or subcymbiform, four-septate, with three central coloured cells, not or slightly constricted, triciliate, (without pedicel or cilia) 17–22 x 4–5 μ ; three coloured cells, 10–15 μ long ; basal cell, 2–3 μ long ; pedicel, 2–4 μ ; apical cell, 3–5 μ long ; cilia, 4–10 μ long. On leaves of *Piper nigrum* L., Peradeniya, Feb. 3, 1917 ; No. 5051.

Pestalozzia Flacourtiae Petch, n. sp. Spots large, orbicular, grey or brownish grey above, with a purple margin, pale brown below, closely concentrically zoned on both surfaces ; acervuli epiphyllous, minute, 0·1 mm. diameter, pycnidiiform, opening by a minute pore ; spores fusoid or subcymbiform, four-septate, with three coloured central cells, not or slightly constricted, three or four ciliate, (without cilia or pedicel) 20–28 x 6–8 μ ; coloured cells, 14–18 μ long; basal cell, 3–4 μ long; pedicel 4 μ ; apical cell, 2–4 μ long ; cilia 12–20 μ long, up to 1 μ broad at the base, rather rigid. On leaves of *Flacourtia inermis* Roxb., Peradeniya, February 21, 1915 ; No. 4503.

Pestalozzia Vangueraie Petch, n. sp. Spots more or less circular, red-brown, obscurely zoned. Acervuli epiphyllous, subepidermal, then widely open, up to 0·2 mm. diameter ; spores fusoid or subturbinate, straight or curved, four-septate, with three central coloured cells, 16–24 x 7–8 μ, triciliate ; coloured cells 12–16 μ long ; basal cell, 3–4 μ long : pedicel, 4 μ ; apical cell, 2–4 μ ; cilia, 4–14 μ. On leaves of *Vangueria edulis* Comm., Peradeniya, February, 1915 ; No. 4504.

Pestalozzia Cinnamomi Petch, n. sp. Spots circular, grey, with a narrow purple margin. Acervuli chiefly epiphyllous, subepidermal, becoming widely open, up to 0·2 mm. diameter ; spores fusoid or subcymbiform, four-septate, with three central coloured cells, the lowest frequently paler than the other two, two or three ciliate, 15–18 x 6–8 μ ;

coloured cells 10–15 μ ; basal cell, 3 μ ; pedicel 4 μ ; apical cell 1–3 μ ; cilia 4–12 μ. On leaves of *Cinnamomum zeylanicum* Bl., August 1907 ; No. 2501. Also on *Litsea fuscata* Thw., Hakgala, May 1912 ; No. 3501.

Piricularia Oryzae Cav. On *Oryza sativa* L., Gangaruwa, May 1922 ; etc. On *Panicum repens* L., Gangaruwa, May 1922.

Ramularia areolae Atk. On cotton, Nalande, April 1924.

Cladosporium superficiale Petch, n.sp. Hypophyllous, forming black, circular, superficial, floccose patches, about 1·5 mm. diameter ; conidiophores up to 100 μ high, 4 μ diameter, equal, regular, septate, black or fuliginous ; conidia usually fusoid or cylindric, one end rounded, the other acute, fuliginous, three-septate, rarely four-septate, 14–20 x 4–5 μ, with a few, one-septate, oval, 8 x 5 μ. On leaves of *Cinnamomum ovalifolium* Wight, Hakgala, February 1922 ; No. 6570.

Differs from *Cladosporium congestum* B. & Br. in colour, and in the shape of the hyphae and conidia.

Acrothecium lunatum Wakker. On *Sorghum vulgare* Pers. ; Peradeniya, June 1921 ; No. 6291.

Actinostilbe, gen. nov. Stilbacearum. Synnemata cylindrica, sursum in disco, a paraphysibus cincto, expansa ; conidia hyalina uniseptata.

Actinostilbe Vanillae Petch, n. sp. Synnemata erumpent, cylindric, up to 0·3 mm. high, 0·2 mm. diameter, expanding above into a fringed disc, 0·3 mm. diameter ; disc sometimes almost sessile ; stalk of parallel agglutinated hyphae, yellow ; disc whitish, convex ; marginal paraphyses yellow-brown, up to 100 μ long, 4–6 μ diameter, septate, minutely spinulose, terminating in an oval or clavate tip 6–10 μ broad ; basidia up to 18 μ long, 2 μ diameter, fusoid, attenuated above, clustered at the apices of the conidiophores ; conidia apical, solitary on a slender sterigma, hyaline, oblong-oval, ends obtuse, one-septate, 5–8 x 2 μ. On stems of *Vanilla planifolia* Andr., Peradeniya, May 1922 ; No. 6454.

Graphium cylindricum Petch, n. sp. Solitary, or connate at the base in groups, arising directly from the substratum or from a byssoid stroma, up to 1·5 mm. high, more or less cylindric, slightly inflated above, 0·2 mm. diameter ; stalk black, dark-brown by transmitted light, continued as a columella almost to the apex ; head greyish white, rather loose, peripheral layer more or less discontinuous ; conidiophores spreading, stout, 3 μ diameter, suberect or curving out and becoming horizontal, up to 130 μ long, repeatedly branched, the upper branches whorled and about 12 μ long, pale fuscous, bearing one or more conidia on short sterigmata ; conidia pale fuscous, narrow-oval, ends obtuse, 5 x 2·5 μ. On dead wood, Peradeniya, June 1921 ; No. 6272.

Didymobotryum atrum Pat. var. **pachysporum** Penz. and Sacc. On *Oncosperma*, Peradeniya, August 1921 ; No. 6288.

Arthrobotryum infundibuliforme Petch, n. sp. Up to 0·8 mm. high, black, head grey ; stalk of fused parallel hyphae, 32 μ diameter below, 16 μ diameter above, arising from a brown disc of hyphae united laterally ; head oval, up to 80 μ high, 60 μ diameter, the outer layer of the stalk hyphae terminating about half way up the head and forming a pale brown funnel enclosing the conidiophores ; conidia hyaline, becoming pale fuliginous, narrow-oval or fusoid, one to three-septate, ends acute, 14–20 x 3–3·5 μ. On leaves of *Cinnamomum ovalifolium* Wight, Hakgala, February 1922 ; No. 6568.

Tubercularia leguminicola Petch, n. sp. Sporodochia superficial, pink, waxy, compact, scattered or clustered, up to 0·5 mm. diameter ; parenchymatous base small or almost absent ; conidiophores 50 μ high, branched dichotomously above, the ultimate branches 16 μ long, 2 μ diameter, subfusoid, acute ; conidia hyaline, 4–6 x 2 μ, narrow-oval. On pods of *Bauhinia* sp., Peradeniya, Oct. 1923 ; No. 6729.

Bactridium album Petch, n. sp. Sporodochia pulvinate, white or cream coloured, minute, circular, up to 0·5 mm. diameter ; conidia hyaline, clavate, thin-walled, multiseptate, apex rounded, 90–120 x 12–13 μ. On decaying wood, Hakgala, February 1923 ; No. 6611.

Epicoccum Theobromae Petch, n. sp. Spots white, subtranslucent ; acervuli hypophyllous, black, shining, minute, up to 0·15 mm. diameter, or confluent in patches; conidia circular, 5–6 μ diameter, or oval, 6 x 5 μ, dark fuscous, smooth. On leaves of *Theobroma cacao* L., Peradeniya, September 1922 ; No. 6545.

Chaetostroma viride Petch, n. sp. Stromata minute, up to 0·25 mm. diameter, pulvinate, black, surrounded by setae at the base ; setae up to 150 μ high, 6 μ diameter below, tapering upwards, apex acute, thick-walled, septate, pale green ; conidia dark green in mass, pale green separately, oval, ends acute, 3–5 x 1·5–2 μ ; conidiophores up to 30 μ high. On twigs of *Camellia theifera* Dyer, Mooloya, May 1922 ; No. 6433.

Spegazzinia meliolicola P. Henn. On a *Meliola* on *Memecylon*, Peradeniya, August 1913 ; No. 6571.

Notes on Ceylon Clavariae

BY

T. Petch, B.A., B.Sc.

Clavaria miniata Berk.

Berkeley described this species, from South Africa, in Hooker's London Journal of Botany, II (1843), p. 416, the description being "parva, cinnabarina, stipite tenui attenuato in clavulam palmato-subifidum compressiusculum sursum incrassato. On sandy ground among mosses." Subsequently, he recorded it from Ceylon, among the fungi sent by Gardner, Gardner No. 30, but it was not recorded by Berkeley and Broome among the fungi sent by Thwaites, more than twenty years later.

There is no difficulty in determining which Ceylon species was intended. It is a very common Clavaria which occurs all over the wet low country and up to at least an elevation of 4000 ft. during the rains, in large patches, always on well-trodden footpaths. It apparently does not occur on loose soil, or on sand or gravel paths, but on bare, compact, clay-like soil, *e.g.*, estate footpaths. Gardner's specimen is marked "On the ground in open places."

As already stated it was not recorded from Thwaite's collection. But it is so common and of so regular occurrence that it is scarcely possible that it was not included. In fact, it is Thwaites' No. 67, which was assigned by Berkeley and Broome to *Clavaria argillacea* Fr. and *Clavaria inaequalis* Fr. With regard to the specimens assigned to the latter species, Berkeley and Broome stated "Exactly the form figured by Greville. Spores 0.00015 (inches)." The spores of the Peradeniya herbarium specimens of Thwaites 67 are 8–10 by 4–5 μ, but the specimens are mouldy and numerous other foreign spores are present.

Whether the Ceylon species is identical with the South African has not been ascertained. The former is sometimes flattened and expanded at the apex, but in general it is not, and its habitat would appear to be different from that of the South African species.

The Ceylon species is gregarious, growing in troops, but usually not fasciculate, 5 mm. to 3 cm. high, 1–1.5 mm. diameter, fusiform or linear,

cylindric, straight or flexuose, sometimes curved and twisted, simple, apex obtuse, sometimes flattened above and 2–3 mm. broad, orange-red, becoming pinkish red when dry, internally the same colour, sometimes orange yellow at first in very wet weather ; hyphae of the context, 2–4 μ diameter ; basidia clavate, 4-spored, 24–36 by 4–6 μ ; sterigmata hair-like ; 6 μ long ; spores white , pinkish in mass, 8–14 by 3.5–5 μ, oblong-oval or somewhat clavate, with an excentric apiculus.

This does not appear to differ from *Clavaria helicoides* Pat. and Demange, from Tonkin. The dimensions of the spores of the latter are not given. M. Demange, who saw the Ceylon species growing at Peradeniya, stated that the Tonkin species differed in being always curled and twisted. The Ceylon species is straight as a rule, but in drier weather some examples are curled and twisted.

I have not been able to trace this species among the Javan Clavariae described by Van Overeem.

Clavaria laeta B. & Br.

This species grows on the ground among grass. It resembles *Clavaria fusiformis* in shape, but is orange red, coral red, or blood red.

Fasciculate, simple, connate at the base, up to 9 cm. high, 2–4 mm. diameter, fusoid, attentuated above and below, the larger specimens compressed and sulcate, apex obtuse, slightly tomentose at the base, stuffed, internally red or pink throughout ; basidia cylindrico-clavate, 4-spored, 30–45 by 4–6 μ ; sterigmata awl-shaped or elongated conical, 7–10 μ long ; spores white, spherical or subglobose, 4–5.5 μ, usually with a short stout apiculus, about 0.6 μ, long.

Van Overeem's figure of *Clavaria sanguineo-acuta* (Icones Fungorum Malayensium, Plate III, fig. 8) exactly represents small examples of *Clavaria laeta*.

Clavaria vermicularis Fr.

Fasciculate in groups of three or four, white, waxy, up to 6 cm. high, cylindric, up to 3.5 mm. diameter, or compressed, up to 4.5 mm broad, attenuated towards the base, equal or attenuated at the apex, simple, often longitudinally sulcate, sometimes irregularly forked, internally white, stuffed ; spores white, oval, 5–6 by 3 μ.

This species occurs among grass in the Palm Grove at the entrance of the Royal Botanic Gardens, Peradeniya, in company with *Clavaria fusiformis* and *Clavaria laeta*, but appears more rarely than either of those. It was apparently not collected by Thwaites.

Clavaria fusiformis Sow.

This was recorded for Ceylon by Berkeley and Broome from Thwaites

678, 680, *cum icone*. It grows among grass in company with *Clavaria laeta* and *Clavaria vermicularis*. The colour varies with weather conditions and age between chrome yellow, orange yellow, lemon yellow, and pale yellow. In drier weather the clavae acquire a whitish bloom, but they regain their original colour when placed in a damp chamber.

Fasciculate, up to 9 cm. high, 2–3 mm. diameter at the base, 5 mm. in the middle, exceptionally 16 cm. high, 1 cm. diameter, fusiform, terete, or flattened and sulcate, simple, apex acute or obtuse, sometimes crested with a few short points in small examples, internally pale yellow, or chrome yellow becoming paler in the centre, stuffed then hollow; hyphae in the centre of the clava up to 8 μ, diameter, minutely verrucose; basidia clavate, 4-spored, 18–24 by 6–8 μ; sterigmata conical, 3–6 μ high, 1 μ diameter at the base; spores white in mass, spherical, 4–7 μ diameter, with a cylindrical apiculus.

In the Ceylon, form the apex is usually the same colour as the remainder of the clava, but it may turn brown in old specimens. Thwaites' figure shows the clavae with brown tips.

Clavaria vermiculata Micheli.

Simple, solitary or fasciculate, clavate or almost equal, terete, up to 5 cm. high, 2 mm. diameter, apex abruptly conical or obtuse, tapering towards the base, white, apex becoming translucent, glabrous and shining at the base, dull above, brittle; spores white, broadly oval or subglobose, 5–8 by 3–5 μ, apiculus terminal. On the ground, Peradeniya.

Clavaria subaurantiaca Henn. & Nym.

Fasciculate, up to 10 cm. high, 5 mm. diameter, fusiform, frequently curved, twisted and irregularly fistulose, laterally compressed and longitudinally sulcate, apex usually subacute, often rounded, dull orange or reddish orange, internally orange, stuffed becoming hollow, base strigose; spores pale yellow in mass, globose, 4–6 μ diameter. On the ground among grass, Peradeniya.

? **Clavaria luteo-tenerrima** Van Overeem

Simple, gregarious, up to 5 cm. high, 0.5–1 mm. diameter at the base, soon expanding upwards to 1.5–3 mm. diameter, terete, sometimes flattened and sulcate, apex obtuse; small specimens curved, about 1.5 cm. high, 1 mm. diameter at broadest; at first pale yellow, translucent, then orange yellow, sometimes reddish orange and horny-looking at the base, becoming orange red on drying, internally fibrillose, yellow; spores white in mass oblong oval, 6–9 by 4–5 μ, with a large sublateral

apiculus. On the ground among dead leaves, Peradeniya ; No 2950. July 11, 1909 ; etc. Stains paper yellow.

Clavaria zylogena B. & Br.

This species was described by Berkeley and Broome in Fungi of Ceylon, No. 684, as " Simplex, pusilla, albida, acutissima, pulverulenta, e communi basi fasciculatim oriunda (No. 675). On dead wood, Peradeniya, July 1868. Dispersed in little scattered fascicles, or more rarely single, ¼ inch high. Spores elliptico-subfusiform, .0005 long, .0002 wide."

The fungus is up to 5 cm. high, 0.5 mm. diameter, simple, or once branched above, or sometimes dividing into a cluster of erect branches, fasciculate, adjacent clavae frequently fused, cartilaginous, white or brownish white, internally pale brown, subtranslucent ; spores white, oval, apiculus oblique, 12–15 by 6–7 μ. Specimens have been collected on bamboo, Peradeniya, November 1914 ; No. 4310.

This species is a Pterula, and will stand as *Pterula xylogena* (B.and Br.).

Clavaria xylarioides Petch

The specimens described under this name resemble in shape those figured by Van Overeem as *Clavaria fusco-lilacina* Berk. (Icones Fungorum Malayensium, Plate II, fig. 4). Only simple examples have been found, and they differ in colour from the latter species, being violet-black, black at the base, instead of violet light brown, or dark brown violet, ochre brown at the base. The basidia and spores are also different. The species at first sight might be taken for a Xylaria or a Geoglossum.

Clavaria violacea Petch

As pointed out by Van Overeem, this species is probably identical with that identified by him as *Clavaria Zollingeri* Lév. One would, however, scarcely describe it as roseo-amethystina. Lévéille described *Clavaria Zollingeri* as " Pedicule court, nu, irrégulier ; les rameaux peu nombreux, étalés, d'une belle couleur rosée tirant sur le violet. La division dichotomique des rameaux," etc. Van Overeem translates this as " äste wenig zahlreich, dichotom verzweigt ; Stiel kurz und glatt und Farbe rosa, übergehend in schön violett." The latter version may, as he states, agree well with the species he regards as *C. Zollingeri*, but it has not the same meaning as the original.

Clavaria Zippelii Lév.

In Fungi of Ceylon, No. 673, Berkeley and Broome recorded *Clavaria formosa* Fr., from Thwaites 552 and 676 in part, giving the localities

"South of the Island, July 1868; Central Province, Dec. 1868." In No. 674 of the same list, they described *Clavaria Thwaitesii* B. & Br., "Trunco crasso, ramis pluries divisis apicibus fuscis; sporis subglobosis (No. 552). Central Province, Dec. 1868; Damboul, March 1868."

After *Clavaria Thwaitesii*, Berkeley and Broome added the note, "Exactly the form of *Clavaria formosa*, but the spores in that species are broadly fusiform and granulated. No. 676 is a variety with the division more as in *C. stricta*. Spores subglobose, even, with a large nucleus, 0.00035 in diameter (i.e., 9 μ). Under the same number from the South of the Island, July 1868, is a still more strongly divided form, with a narrow stem, but the spores exactly the same."

It will be noted that, although Berkeley and Broome referred to No. 676 as a variety of *C. Thwaitesii*, they cited that number for *C. formosa* only. Similarly the specimen from the South of the island is mentioned under *C. Thwaitesii*, but that locality is cited only for *C. formosa*.

As far as I was able to discover, there is no Ceylon specimen of *Clavaria formosa* in the covers of that species in Herb. Kew. The specimens, Thwaites 552 and 676, five sheets, are all included under *Clavaria Thwaitesii*. All these, including the strongly divided form, have oval or pyriform, warted or echinulate spores, with a few globose and echinulate. In Herb. Peradeniya, the specimens, Thwaites 552, have the same spores. There are also in Herb. Peradeniya, sections of a large specimen, up to 12 cm. high, with long straight terete branches, which are probably parts of the strongly divided form noted by Thwaites; the stalk appears narrow, but it is really a section of the stalk which has curled up in drying. These latter specimens are loose, and are not accompanied by any Thwaites' number, but the paper in which they are contained is marked "Clavaria sp. Thwaites coll." by J. B. Carruthers. These specimens have the same spores as Thwaites 552 and 676 in Herb. Kew.

In Herb. Peradeniya, there is a sheet marked by Thwaites, 676, S. of the Island, which is totally different from any of the foregoing. The specimens grew on wood, and are up to 5 cm. high. They divide almost from the base, repeatedly at a narrow angle, into slender branches about 1 mm. diameter, the tips of the ultimate branches being penicilliate with several rather long slender processes. The spores are hyaline, smooth, broadly oval, 5–7 by 4–5 μ, or globose, 5–6 μ, with a short cylindrical apiculus. I have not noted this form in Thwaites 676 in Herb. Kew, and it is clear that this cannot be *Clavaria Thwaitesii*, as it does not in the least resemble *Clavaria formosa*. Evidently there has been some confusion of specimens.

There does not appear to be any specimen in the type of *Clavaria*

Thwaitesii in Herb. Kew which has globose smooth spores. There is a possibility that such may be found in the Broome collection in Herb. British Museum. But on the specimens examined, *Clavaria Thwaitesii* B. and Br. is identical with the specimens assigned to *Clavaria formosa*. Moreover, these are not *Clavaria formosa*, but *Clavaria Zippelii* Lév.

Clavaria Zippelii has been collected recently at Peradeniya and Hakgala. It differs considerably in degree of development. Some forms are about 6 cm. high, with a stem about 1 cm. diameter, which divides at about half the height of the fungus into several stout branches. the angle of branching is small, and the outer branches usually curve upwards so that all the branches are more or less parallel. These branches, in the smaller forms, divide above into a few stout, terete, more or less conical, obtuse points. In larger specimens the main branches may divide repeatedly at a wider angle, the ultimate branches terminating in the same manner as described above. In other cases, the tips at the ends of the stout branches are prolonged into terete branches, up to 3 cm. long, either simple, or shortly forked at the apex ; these branches all stand erect and form a more or less compact bundle.

The fungus is fawn-coloured or greyish brown, with blue or greenish-blue tips. Internally it is white, turning purplish when cut. The mycelium is white, and becomes slightly purple when handled. The spores are yellow-brown, usually unequally pyriform, or pyriform and curved at the narrow end, sometimes oval, sometimes globose, strongly echinulate with spines up to 2 μ long, or merely verrucose. The pyriform spores are paler, and less spinulose, or almost smooth, at the narrow end. The oval and pyriform spores measure 10–16 by 6–8 μ ; the globose spores are about 8 μ diameter.

The blue tips are a marked feature of this fungus in Ceylon, whether the stumpy form with short tips or the taller form with proloned tips. Van Overeem (Bull. du Jardin Botanique, Buitenzorg, Ser. III. V. p. 278) criticises Von Höhnel's statement regarding the blue tips of this species at Buitenzorg, and declares that a blue colour is scarcely ever to be seen on the specimens which now occur there. Van Overeem states that he has never found forms with beautiful blue tips among the numerous examples he has seen, and that blue tips occur only on completely "ausgewachsen" examples ; the specimens in the Botanic Gardens, Buitenzorg, are never "ausgewachsen," and therefore their tips are not blue. This is quite at variance with the behaviour of this species in Ceylon.

Clavaria fragillima Sacc. & Syd.

Coralloid, up to 14 cm. high ; main stem stout, 8 mm.–2 cm. diameter, dividing above repeatedly at an acute angle, ultimate branches

short, terminating in a few conical divaricating points ; in smaller specimens, sometimes dividing abruptly into numerous comparatively slender branches, which are shortly divided at the apex and terminate in smaller points ; base clothed with white mycelium which turns purple when bruised ; in the larger specimens, brownish with a purple tinge below, ochraceous or orange above, in the smaller specimens, entirely ochraceous or orange ; internally white, becoming purplish when cut ; spores ochraceous in mass, yellow brown by transmitted light, narrow oval, or fusoid and inequilateral, pointed at one or both ends, strongly spinulose, 9–12 by 4–5 μ. On the ground, Hakgala ; No. 2661, September 1908 ; No. 4118, September 1914.

The colour of the Ceylon specimens is much brighter than that of Van Overeem's figure (Icones Fungorum Malayensium, Plate I, fig. 3), and the figure does not show clearly the divaricating tips which are a marked feature of the Ceylon fungus and distinguish it from all forms of *Clavaria Zippelii*.

Clavaria megalorhiza B. & Br.

Berkeley and Broome described this species in Fungi of Ceylon, No. 675, as " ochracea multifida e mycelio radiciformi oriunda, apicibus acutis ut plurimum penicillatis ; sporis ochraceis (No. 197). On wood. Central Province, Dec. 1868. About 1½ inch high." Some of the specimens in the type in Herb. Kew grew among dead leaves, etc. One has a stout stalk ; the others are thin and clustered, bound together by mycelium below ; one has a long mycelial strand attached.

The fungus is bushy, arising from a single short stout stem, or from several stems which are bound together by a sheet of mycelium. The stems divide repeatedly, usually from near the base, at an acute angle, the upper branches often being broadly expanded at the point of division. The ultimate branches terminate in a cluster of erect terete processes, a few millimetres long. The total height is up to 4.5 cms. and the diamater up to 2.5 cms. The colour is white, often with a purplish tinge, becoming yellow brown when old. The spores are yellow brown in mass, pale yellow brown by transmitted light, oval, oblong oval, or subpyriform, spinulose or minutely verrucose, 5–7 by 3–5 μ in a spore print from fresh specimens. On the old herbarium examples the spores are 5–6 by 3 μ, frequently cohering in fours.

Thwaites 1004 was assigned by Berkeley and Broome to *Clavaria byssiseda* Pers. The specimens have a taller main stem than those of Thwaites 197, but they are the same species. Thwaites 1005, which was assigned to *C. stricta* P. is again the same species ; the specimens grew among dead leaves and some individuals arise from a sheet of mycelium.

Among the fungi collected by Beccari in Ceylon, Cesati described *Clavaria intricata* Ces., as " Ochrospora, cervina, 1½ inch alta, caespitosa, ramosissima, ramis tenuibus, flexousis, intricatis, apicibus saepius penicillatus." It would seem probable that this is identical with *Clavaria megalorhiza* B. & Br., but I have not seen the type specimen.

Clavaria megalorhiza grows on the ground, often among dead leaves, or on very rotten wood. In the latter case it arises from coarse, but lax, white, rooting mycelium, the strands of which are up to 4 mm. diameter.

Clavaria echinospora B. & Br. and C. **semivestita** B. & Br.

Clavaria echinospora B. & Br. was described as " Repetiter furcato-ramosa, a mycelio stipitiformi oriunda, sicca nigra, sporis ellipticis echinulatis. Peradeniya, July 1868." The description was followed by the note " Undoubtedly allied to the last (*C. megalorhiza* B. & Br.); but the spores are larger and the whole plant becomes black when dry. No. 677 (Peradeniya, July 1868) seems, however, to be a variety of *C. megalorhiza*, which becomes darker in drying. Spores broadly elliptic, strongly echinulate, .0002–.00025 long, .0001–.00015 broad." This spore measurement refers to *C. echinospora*.

Clavaria semivestita B. & Br. was described as "Fasciculata ochracea ramis cylindricis furcatis, e trunco tenui oriundis, deorsum tomentosa ; apicibus acutis (No. 677 in part). On the ground. About 1 inch high. Half the plant is covered with short down."

It will be noted that no Thwaites' number is cited for the type of *C. echinospora*. In Herb. Peradeniya, *C. echinospora* and *C. semivestita* are on the same sheet, which is marked on Thwaites 677, Central Province. Peradeniya is in the Central Province, but in Thwaites' lists, Central Province usually means a locality other than Peradeniya, and frequently Hakgala. In Herb. Kew, the only specimen under *Clavaria echinospora* is No. 677, marked " *C. echinospora* B. & Br. *Clavaria macrorhiza* B. & Br. var. Peradeniya, July 1868." (Berkeley and Broome wrote " macrorhiza " on the herbarium specimens, but published the name as " megalorhiza "). Consequently, either the type of *C. echinospora* is missing, or Berkeley and Broome's note under that species is incorrect, in that it relates to the type, not to another specimen. The latter appears to be the true explanation. Other specimens of Thwaites 677 are included in Herb. Kew under *Clavaria semivestita*, and there is a further specimen, *sub C. megalorhiza*, marked in pencil, Ceylon, 677, *ex* Herb. Currey, which is also *C. semivestita*.

Clavaria echinospora B. & Br. Bushy, forming more or less depressed-globose tufts up to 10 cm. diameter and 7 cm. high, arising either from a

single stem or a cluster of stems ; stems up to 5 mm. diameter, terete or compressed, soon dividing repeatedly and more or less dichotomously at an acute angle on the inner branches, but at a wide angle on the more horizontally spreading outer branches ; ultimate branches on fully developed examples long, terete, tapering regularly, simple or bifid, apex usually subacute ; immature branches often flattened at the apex and crested with a few conical processes ; cartilaginous, somewhat subtranslucent, pallid or brownish below, pale purple or lilac above, slightly white tomentose at the base, elsewhere with a glaucous bloom, becoming black on drying ; spores white in mass, coarsely spinulose with short broad-based spines, or coarsely tuberculate, or nodular, oval, 4–7 by 3–4 μ. Frequent at Peradeniya, on the ground among grass.

Van Overeem has suggested that *Clavaria echinospora* is identical with *Clavaria Zippelii*, in spite of the fact that scarcely a single detail of the description is applicable to the latter. He finds support for his suggestion in Berkeley and Broome's statement that the spores are larger than those of *Clavaria megalorhiza*, but he has misinterpreted their reference and has assumed that the spore measurement given under *Clavaria echinospora* is that of *Clavaria megalorhiza*. Moreover, *Clavaria echinospora* has hyaline spores, not brown spores.

Clavaria echinospora is probably identical with the Javan species assigned by Van Overeem to *Clavaria implexa* Lév., though, if so, his figure on the latter (Icones Fungorum Malayensium, Plate I, fig. 3) scarcely represents correctly the long straight tips. Unfortunately, Van Overeem does not give any indication that he has examined the type specimens of Javan fungi, and consequently his references to these ancient species are doubtful. As is well-known to all who have taken the trouble to look up the old type specimens of fungi, they frequently do not correspond with the description and may even not have been placed in the correct genus.

Clavaria semivestita B. & Br. Up to 4.5 cm. high ; clustered, in groups of three or four, or in tufts up to 3 cm. diamater ; primary stem terete, up to 3 mm. diameter, but usually thinner, soon dividing above at a wide angle, each branch dividing dichotomously about twice, axils often rounded ; tips usually simple, acute or obtuse, sometimes up to 1 cm. long ; white, then brownish, yellow brown when old, minutely pruinose to varying heights, tips glabrous ; when dry, minutely tomentose and rufous or pale brown below, glabrous and dark brown above ; spores white in mass, hyaline by transmitted light, smooth, globose, 5–7 μ diameter, with a cylindric apiculus up to 2 μ long. On the ground among grass ; frequent at Peradeniya.

The tomentose covering, from which Berkeley and Broome derived the

name, is not noticeable until the specimens have been dried. *C. semivestita* apparently resembles *C. alcicornis* Zoll. et Mor., as re-described by Van Overeem, but it is white at first and the brown colour is not due to the spores.

Clavaria candelabrum Massee

Bushy, up to 6 cm. high, waxy, pallid or brownish white, sometimes slightly purplish at the base; main stem stout, sometimes branching almost from the base, sometimes continuing as a central stem for half the height of the fungus, giving off distant lateral branches; branches arising at a wide rounded angle, often decurved from the point of origin, then curving upwards vertically, expanding upwards, and dividing into a cluster of thinner branches with the same wide rounded angle, this mode of branching being repeated two or three times until the branches terminate in a cluster of slender conical processes arranged exactly as the lower branches; base strigose with brown mycelium which forms a pad over the substratum; the whole fungus brown to blackish brown on drying, spores white, globose, 3–4 μ diameter, or oval 3–4 by 2–3 μ. On dead wood, Hakgala.

Well-grown specimens of this species are remarkably regular. The primary branches bend downwards in a wide curve, and then turn upwards into a vertical position, becoming parallel to one another. At about the same height, all these divide into secondary branches, with exactly the same curve, which form a broader cluster of parallel vertical branches; and this is repeated two or three times, forming successive tiers of parallel branches. I have not seen the type specimen of *Clavaria candelabrum*, but the name is irresistible.

Epipogon nutans

BY

T. Petch, B.A., B.Sc.

WITH ONE PLATE.

Epipogon nutans Lindl. was formerly common in the shrubberies of the Royal Botanic Gardens, Peradeniya, and especially so in the Nutmeg Grove, where the ground was covered with a thick carpet of decaying leaves. The best specimens I have seen, however, and the largest number at one time, have been on cacao estates in Dumbara, where it luxuriates in pockets filled with decaying leaves among the roots of the cacao.

As recorded in the Flora of Ceylon, the scape may be up to 20 inches high and one-third of an inch in diameter. It arises from one end of a pale yellow brown, ovoid or oblong-ovoid tuber, which may be up to 3 inches long. The tuber (Plate XVI, fig. 3) lies horizontally in the soil, and the larger specimens are somewhat flattened ; it is encircled at intervals of two or three millimetres by more or less parallel lines, which, as stated in the description of the plant in the Flora of Ceylon, are leaf scars. These lines mark the nodes. The tuber is a shortened rhizome, with internodes two to three millimetres long. For the sake of clearness, the term tuber will be retained for this organ, and the term rhizome employed for a different structure.

The scape (Plate XVI, fig. 1) is white and somewhat translucent. It bears adpressed membranous scale leaves below. The flowers are similarly white and subtranslucent, or sometimes spotted with red. The plant has no roots and no true leaves. When in flower it consists of a tuber and a flowering stem only. The tuber is solid at first, but as the scape develops it becomes hollow. Similarly the developing scape is solid at first, and becomes hollow as it increases in height. When flowering is completed, the tuber is collapsed and only an empty shell is left. After flowering, nothing of the parent plant remains alive. That has been determined repeatedly from examples flowered in pots, as well as from plants in their natural habitat.

At an early date in my residence in Ceylon, some observations were made on this plant, and it was intended to carry out further investigations, but for various reasons these were never undertaken. Some data were, however, obtained, and these are recorded here to direct attention to a few peculiar features in the life history of this species which require elucidation.

Small tubers, about 2 cm. long and 1 cm. diameter, which have not begun to flower, bear membranous scale leaves at the nodes toward the apex, or growing point. The scale leaves of one node do not extend over the next node, *i.e.* they are not more than two or three millimetres long. In addition, the nodes bear a dense fringe of hairs. Further back towards the base of the tuber, the same fringe of hairs is present at the nodes, but the scale leaves have for the most part disappeared, and only their bases persist. The scale leaves are so thin and small that they are not discernible until the tuber is examined carefully. They are free, and can be lifted up with a needle. The scale leaf bears numerous hairs on its outer surface, and the same hairs occur more sparingly over the internodes.

The hairs are up to 2 mm. long, generally simple, but sometimes with a septum towards the base, hyaline at first, becoming yellow brown, rough and often irregular at the tip. They resemble root hairs. They stain brown with chor-zinc-iodide, even in the young stage on the rhizome which will be referred to later, and are evidently cuticularised. Owing to the presence of these hairs the surface of the tuber is slightly matted tomentose, but this is not a conspicuous feature. Similarly hairs also occur on the scale leaves on the flowering stem and on the bracts.

Fungus hyphae occur among the hairs, but are comparatively scanty. They vary from hyaline to purple brown, and in diameter from 2 to 4 μ. though occasionally one may be up to 10 μ diameter. The purple brown hyphae are for the most part regular, but here and there geniculate. Hyphae are present in the scale leaves and in the epidermal layer of the tuber, but they rarely occur in the hairs. No hyphae have been observed in the living cells of the interior of the tuber.

If the tuber has not begun to flower, all the parenchyma cells are so completely filled with starch that a cut surface appears granular. In general, the cells are so densely filled with starch that it is not possible to see anything else in them without further treatment. Towards the exterior, for a depth of about three cells, some do not contain starch, while in the others it is less abundant than in the deeper lying tissue.

Here and there, small brown masses of cells, three or four cells deep, extend from the exterior into the tuber, sometimes, but not always, from a node. These cell groups are traversed by a few stout hyphae, usually

distant from one another. There are no masses of hyphae in these cells ; They appear to be dead, and the hyphae merely saprophytic.

Larger tubers which have begun to flower do not present many external differences from the foregoing. Scale leaves may still be present near the apex. The hairs, in general, do not contain hyphae. Hyphae are more abundant than on the smaller tubers, and form a wide-meshed network over the surface. Sometimes a thin membranous sheet composed of hairs and hyphae stretches across the furrow which forms at a node as the tuber becomes exhausted. Under a low magnification, small scattered reticulated patches may be observed on the internodes ; these are formed by fine strands of agglutinated hyphae. But there is no dense weft of hyphae over the tuber, and no strands visible to the naked eye.

As the plant flowers, all the starch is consumed, and the tuber becomes hollow and finally collapses (Plate XVI, fig 1.).

The rhizome referred to below, bears hairs similar to those on the tuber. Hyphae occur among these hairs, but have not been observed within them, or within the rhizome.

The habitat of the plant is first revealed by the appearance of a scape. If the dead leaves are then cleared away, other examples will often be found, some in the early stages of flowering, others which have not yet begun to flower. Thus the tubers are frequently gregarious. Moreover, it was noted on several occasions that in the Nutmeg Grove, where the soil was not disturbed by cultivation,three or four tubers would lie in the same straight line. Further, the tuber frequently has a short appendage, apparently the remains of a dead rhizome, at the basal end (Plate XVI, fig. 2). These facts appeared to point to the existence of some connection between the tubers at some stage of their development.

On one occasion, a tuber was found which had begun to produce a scape, but the upper part of the latter had been broken off. As the tuber was solid, it was evident that the scape had not developed to its full extent before the injury occurred. From near the basal end of the tuber there arose a small white tuber, and a thin white rhizome 24 cm. long. This rhizome was slightly more than 1 mm. in diameter, and showed ten nodes at intervals of 2 to 2.5 cms. It was white, slight hairy with a fluffy whorl of hairs and a developing tuber at each node. The developing tubers arose laterally at the nodes, each in the axil of a small membranous scale leaf, and in three instances they had grown on at the apex, thus forming a lateral branch with a basal swelling.

These rhizomes were subsequently observed on several occasions. Once, three weeks after the dead leaves in the Nutmeg Grove had been swept back, three examples were found near a flowering tuber. One

tuber, 1.8 cm. long and 1 cm. diameter, with eight rings, bore two young white tubers, from each of which a white rhizome about 5 cm. long had grown. Another, 1.2 cm. long and 1 cm. diameter, with indistinct rings, had produced a rhizome about 1 cm. long and 2 mm. diameter. Another bore three developing rhizomes. The rhizomes (Plate XVI, Figs. 4, 5) are 1–2 mm. in diameter, and may arise anywhere on the tuber; most of them are lateral, but some may originate near the base of the damaged flowering stalk and are then almost terminal. They may emerge directly from the tuber, or a small sessile tuber may be first produced which passes into a rhizome at its apex. Sometimes a sessile tuber and a rhizome originate at the same point. Rhizomes are similarly produced by pieces of tubers which have been cut up during digging operations.

The developing scape, which in each case was in the "hook" stage, was cut off three tubers which were then planted in a pot among decaying leaves. Eleven days later, the largest was producing three rhizomes, and the other two, three and two respectively. Three months later it was found that the old tubers had decayed, and numerous white rhizomes with minute lateral tubers were lying free among the leaf mould, but these young tubers were only 1–2 mm. diameter. Subsequently they decayed.

In one of the examples noted in the foregoing paragraph, a rhizome arose from the flowering stalk near the cut surface.

Four tubers, varying from three to four centimeters in length, which had not yet begun to flower, were taken, the conical apex, about 5 mm. long, cut off each, and the tubers then planted in pots, being half embedded in soil and then covered with decayed leaves. Three weeks later only the largest (A) showed the points of developing rhizomes. As the soil conditions appeared unsuitable, these were modified by embedding the tubers in decayed leaves above the soil. In another fortnight, two small sessile tubers, 2–3 mm. diameter, had developed on A, and another (B) had begun growth. After two months, A had produced a long rhizome which could not be followed without damage; B had produced a strong rhizome; but C and D still did not show any growth. After three months, A had two rhizomes, 1.5 mm. diameter, which bore developing tubers up to 4 mm. diameter, and a cylindrical, elongated tuber 11 mm. long, 5 mm. diameter, arising at the point of origin of one of the rhizomes; B had a rhizome, 7.5 cm. long, 2 mm. diameter, with small developing tubers at the nodes; A and D were just starting to produce rhizomes. After five months, the old tuber of A had disappeared and small tubers were present; B had a rhizome 22.5 cm. long; C had two rhizomes, one 7.5 cm. and the other 16 cm., both bearing developing

tubers; D had also two similar rhizomes. The pots were not examined again for another five months. Nothing was then found in any of them except in A, which contained one tuber, 1.8 cm. long, 1.1 cm. diameter. with eight rings. This was replanted, but when examined again a month later, it was found to have developed another rhizome. 11.5 cm. long; this rhizome developed from the apex of the tuber, *i.e.* in the position of the scape.

From a tuber, 3 cm. long and 1.5 cm. diameter, the developing inflorescence, 3 cm. high, was cut off, and the tuber suspended in a beaker of water, so that the basal 5 mm. was immersed. Ten days later, two rhizomes were appearing, and after seventeen days, nine had been produced, one from each of the internodes above the water. The two lowest internodes which were immersed in the water did not produce a rhizome. The rhizome from the uppermost internode remained small, about 2 mm. long; that from the second internode was about 1 cm. long; that from the third 1.5 cm., with a developing tuber 1 cm. from the base; that from the fourth about 2 cm. long; that from the fifth, 3 cm. long, extending to the water, with two developing tubers; that from the sixth, 1 cm. long, but with two tubers; that from the seventh, 5.5 cm. long, with two tubers, and a swollen base, 2.5 mm. diameter; that from the eighth 3.5 cm. long, with two developing tubers; that from the ninth, 5 cm. long, with two developing tubers. These rhizomes were arranged in a two-fifths phyllotaxy. The swollen bases of the rhizomes and the nodes were clothed with radiating hairs up to 2 mm. long, and the same hairs were scattered along the internodes. These hairs exhibited active protoplasmic streaming.

The foregoing specimen was left for a fortnight longer, during which time the rhizomes lengthened further. At the same time a white mycelium began to develop from the base. Pustules of Cephalosporium and Fusarium then arose all over the tuber, and these were followed by the perithecia of a Nectria. This proved to be *Nectria haematococca* B. & Br. (*Nectria Bolbophylli* P. Henn.), which is the common Ceylon Nectria on decaying vegetable matter.

Thus if the growing point of a tuber of *Epipogon nutans* is cut off, or if, after it has begun to flower, the scape is removed, the tuber will produce one or more long white rhizomes, 1–2 mm. diameter, on which new tubers are produced laterally. Obviously, this procedure is abnormal. The rhizome and the new tubers are produced at the expense of the old tuber, but under normal conditions that does not occur, the whole of the contents of the tuber being utilised in the production of the inflorescence.

The problem arises, what is the place of the rhizome in the normal

life history of the plant. From the occurrence of the plant as a single tuber, it might be supposed that the seed on germination produced a plantlet which straightway develops into a tuber. That would be comparable with the development of many green-leaved orchids. In that case there would be not any rhizome at any stage of the plant's life history. Alternatively, the seedling might develop directly into a rhizome which bears tubers laterally, the rhizome decaying before the tubers are mature, but in that case one would expect to find these rhizomes among decaying leaves independent of mature tubers. It would appear that this can be decided only by growing the plant from seed.

A specimen in which the emerging scape had attained a height of 3 cms. was dug up and planted in a pot indoors. The apex was then, as usual, decurved, and about 7 mm. long. Four days later, the scape was 3.4 cm. high, but the decurved bud had grown to 2 cm. long. After seven days, the height of the scape was 4.2 cm. and the length of the decurved bud 2.9 cm. It was then covered with a bell glass. Four days later, it had attained a height of 14.5 cm., with a horizontal apex, 3 cm. long, the lower flowers having opened, and in another four days, it had become erect and 26 cm. high. Growth in the earlier stages was most probably retarded by unfavourable conditions.

On one specimen which was under observation during its actual flowering period, three flowers opened on the first day, three on the second, four on the third, two on the fourth, two on the fifth, two on the sixth, and one (the last) on the seventh. The fruits of the flowers which opened on the first and second days dehisced six days, those of the third day five days, and the remainder four days, after the opening of their respective flowers. This early dehiscence of the fruits is in striking contrast to that which obtains in other Ceylon orchids, *e.g.* in *Saccolabium longifolium*, in which dehiscence of the fruits does not occur until they are about twelve months old, and it is no doubt to be correlated with the early decay of the plant after flowering.

Flowering is not dependent upon the size of the tuber. Small tubers, 2 cm. long, may produce a scape and then die. But the size of the tuber governs the dimensions of the scape.

Groom examined specimens of *Epipogon nutans* from Java, but his results differ from those recorded above. He found that the tuber was covered by a densely matted mass of fungus hyphae, and that the scale leaves were so firmly fused to the tuber, except at their apices, that they could be separated only by chemical means. According to that, the external layers of the tuber are formed by adherent scale leaves, not by stem tissue. On Ceylon specimens, however, the scale leaf can be lifted up with a needle and, with a little care it can be detached together with

a strip of the epidermis of the next internode below ; it is then clear that the outer layer of the internode differs from the tissue of the scale leaf the latter having elongated cells down the centre, while the former is composed of isodiametric cells.

Groom further states that the hairs have thin, non-cuticularised walls and indubitably function as root hairs and that many of them, contain fungus hyphae which are presumably mycorhizal in nature. But in the Ceylon specimens the hairs rarely contain hyphae and their walls are cuticularised.

The figure of the starch distribution in the tuber, given by Groom, is apparently that of a tuber which has begun to flower. In a non-flowering tuber, the whole section stains black with iodine. The small-celled tissue shown in his fig. 2, Plate 6, occurs only near the apex of the young tuber.

Groom considers that the scales are the absorbing organs of the plant ; the mycorhizal hyphae enter the hairs and occupy all the cells of the scales, and the substances absorbed by the hairs are transported to the bases of the scale leaves and thence into the tuber. But in Ceylon the hairs rarely contain hyphae, and the scale leaves disappear so soon that it would seem improbable that they could function in the manner suggested.

In several respects, the behaviour of *Epipogon nutans* is parallel to that of *Gastrodia elata*, as described by Kusano. The scape of the latter plant develops from the apex of an isolated tuber, which bears nodal scars as in *Epipogon nutans*, but its scale leaves soon disappear, and it is destitute of hairs. In general, the flowering tuber of Gastrodia does not show any mycorhiza. The flowering tuber attains a length of 10 to 17 cms., and there is always a large number of small tubers, down to 2 mm. diameter, lying round it. After flowering the tuber dies.

The non-flowering tubers of Gastrodia give rise to shortly-stalked tubers, or to long rhizomes which bear similar tubers. In the absence of any mycorhiza, these tubers are nourished at the expense of the parent tuber, and consequently they are progressively smaller in successive generations, until they die. This is exactly similar to *Epipogon nutans*, except that, in the latter, the production of daughter tubers appears to be dependent upon the destruction of the growing point of the parent tuber.

According to Kusano's investigations, the rhizomorph of *Armillaria mellea* furnishes the mycorhiza of *Gastrodia elata*. If the rhizomorph comes in contact with a young tuber of the Gastrodia, its hyphae may enter the latter and form an endotrophic mycorhiza. This tuber then increases in size, and constitutes a mycorhizal mother tuber, which

however does not flower, but produces numerous, non-infected, daughter tubers, some of which may develop to a sufficiently large size to produce a flower, while the remainder reproduce vegetatively by offsets and rhizomes, and become smaller with each succeeding generation, unless they happen to become infected by an Armillaria rhizomorph.

Thus, all the nutriment of the Gastrodia is obtained by the mycorhizal mother tuber and is transferred to the flowering and non-flowering daughter tubers. The former do not contain any mycorhiza and hence cannot obtain any food independently, and the majority of the latter are in the same case.

Kusano states that in some instances the Armillaria mycelium behaves as a parasite and destroys the Gastrodia tuber, while in others it forms an endotrophic mycorhiza.

Though Kusano's investigations establish the existence of a mycorhiza within some of the tubers of *Gastrodia elata*, there are several points in his account which appear to require further elucidation. In the circumstances stated, it would seem that it should be an easy matter to discover the mycorhizal mother tubers, and to observe the development of the flowering tubers from them, but from his account it would appear that they have rarely been found, and when found their daughter tubers have not been developed to the flowering stage. His account of this stage of the life history of the plant is consequently largely hypothetical, and is based simply on the fact that mycorhizal tubers can produce daughter tubers,—a faculty which is not confined to mycorhizal tubers only in *Gastrodia elata*. The hypothesis would explain the absence of mycorhiza from the flowering tuber, but the evidence adduced does not appear to support it. It may be noted that Kusano's figure of a mycorhizal tuber producing daughter tubers (Fig. 14) appears to represent a tuber, of which the apex has been destroyed.

Further it is somewhat extraordinary that the daughter tubers so frequently fail to become infected. Kusano states that a great majority of the tubers are always free from the fungus.

Attempts to discover a mycorhizal mother tuber in *Epipogon nutans* have not been successful.

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EXPLANATION OF PLATE XVI

Fig. 1. *Epipogon nutans*, flowering specimen (part of stem omitted); tuber collapsed ; natural size.

Fig. 2. Tuber with a developing scape ; note remains of rhizome at base of tuber ; natural size.

Fig. 3. A small tuber, apex to left, viewed from above ; natural size.

Fig. 4. A rhizome with developing tubers ; the tubers which appear double are linked by a short rhizome, × 2.

Fig. 5. ditto; in both 4 and 5, the attachment of the tubers is not clear, because of the development of hairs at the nodes ; × 2.

NOTES

Characeae and mosquito larvae. When *Nitella oligosperma* Braun and *Nitella sp. aff. batrachosperma* were being grown in the laboratory at Peradeniya, mosquito larvae appeared in large numbers in the dishes. They were all Culicines, probably *Culex fatigans* Wied., which was then frequent in the laboratory. These two species of Nitella were not injurious to Culicine larvae. It may also be noted that *Anopheles spp.* occurred in the ditch from which the Nitellas were collected.——T. Petch.

Wolffia microscopica (Griff.) Kurz. This species occurred in March 1920 at Anuradhapura in a pond near the Post Office. It was not in flower. The writer being then engaged on administrative duties, it was not possible to enquire further into the matter, and he was absent from Ceylon on leave during the early part of 1921. In March 1922, a search was made for the plant, but only *Lemna paucicostata* was found in the locality cited. *Wolffia arrhiza* was abundant in the "well" within the buildings attached to the Ruanweli Dagoba.——T. Petch.

Phreatia elegans Lindl. This species was collected in Ceylon by Macrae (1827-1830), but no locality is given on the single specimen in the Peradeniya herbarium. It had not been collected again in Ceylon until December 1924, when Dr. S. B. Stedman found it in the jungle at Meeriacotta, Maskeliya. In the same locality, Dr. Stedman has obtained *Sarcochilus viridiflorus* HK. f., a rare species orginally collected by Gardner.——T. Petch.

Cirrhopetalum Trimeni Hook. f. As stated by Hooker in the Flora of Ceylon (IV, p. 158), the description of this species is one which Dr. Trimen left in manuscript, there being no specimen in the Peradeniya herbarium nor any figure amongst the drawings. It is probable that the description was a preliminary one drawn up by Trimen on a collecting

tour. What is taken to be this species was collected by Smith at Hakgala in 1906, and has recently been sent in by Mr. A. N. Paine from the Maturatta district. All these specimens agree with Trimen's description, except in one particular, viz. that the lateral sepals are three-veined, not one-veined. The veins are frequently rather close together, and the fact that there are three might then be overlooked. The margins of the dorsal sepal, and the petals, when viewed under a high magnification, are dentate, and the obtuse tip of the petal, which is furnished with a tooth at the apex of the single vein, frequently has two other teeth, one on each side. The dorsal sepal is three-veined.——T.Petch.

Bangala. In Hermann's Musaeum Zeylanicum, p. 51, the Sinhalese name Banghala is recorded, with the note, " Radix transfertur ex Malacca in Zeylonam," and in Hort. Acad. Lugd. Bat., p. 211, Hermann wrote that Bangala Indorum had the same fructification as Curcuma, Cardamomum, etc. Thunberg, Travels, IV., p. 147, stated that Bangle was the Malay name of *Amomum Zingiber* and *Amomum Zerumbet.* Rumphius, however, in Herbarium Amboinense, gave Bangle as the Malay name of *Galanga malaccensis* Rumph. The latter plant has hitherto been taken to be *Alpinia malaccensis* Rosc. of Roxburgh, but Ridley says that it is different and has described it as *Alpinia nobilis* Ridl. If, as Hermann stated, the Ceylon plant was brought from Malacca, it should be *Alpinia nobilis* Ridl. It would be of interest to determine the identity of the plant which passes for *Alpinia malaccensis* Rosc. in Ceylon.——T. Petch.

Cuscuta Chinensis Lam. This species was recorded by Trimen, in Flora of Ceylon, as very rare, only found about Colombo. During the last ten years, it has spread remarkably in the district between Colombo and Kandy, and is a conspicuous feature on the road sides. It is especially noticeable that it is at first confined to the road sides, and this suggests that it is in some way distributed by animals, possibly cattle. It is also remarkable that, although it has been common for the last nine years along the river side road leading to the Experiment Station, Peradeniya, it has only once appeared in the Botanic Gardens on the opposite side of the river, in spite of the fact that the banks on the two sides are covered with similar vegetation. Moreover, its occurrence on the bank on the Botanic Gardens side of the river was at the ferry to the Experiment Station,—a ferry which carries only people and dogs. This would support the view that it is conveyed by animals (including man), while its failure to cross the river at any other point is evidence that it is not spread by birds.——T. Petch.

Turmeric. In Ann. Perad., VII., pp. 160-164, it was recorded that the Ceylon Turmeric had pale green bracts, often with a few longitudinal white stripes or bordered with white, while some of the coma bracts were wholly white. In these respects, and in the colour and structure of the flower, the Ceylon plant was *Curcuma domestica* Val. It was also noted that in some specimens, the coma bracts, especially the uppermost, bore very minute purple red spots, only distinguishable as spots with the aid of a lens, on the upper part of the bract, and chiefly towards the margin, so that the uppermost coma bracts were slightly tinged with purple at the edges. Mention was also made of a specimen, grown as Turmeric in a native garden, in which the bracts were white, with purple or reddish purple tips, the colour becoming more pronounced on the uppermost bracts. In this latter specimen the flowers were immature, and their structure could not be ascertained. This plant has been kept under cultivation, and on subsequent flowering it has been determined that it is *Curcuma domestica* Val. The coma bracts of the latter may therefore be either green and white, or white, or white with purple or reddish purple tips. Hermann stated that the bracts of his *Flos Curcumae* were pale green at first, afterwards " ex flavo rubentia vel ex pallido flava."——T. Petch.

Weeds. *Eleutheranthera ruderalis* (Sw.) Schultz appeared at Henaratgoda in November 1920, in beds of *Chenopodium anthelminticum* grown from American seed. *Richardsonia pilosa* H. B. K. was sent in from a mid-country estate in April 1924, as a weed which was becoming established, with the information that it was called Buta Suri by the Tamils, and that pigs burrowed extensively for the root; there is a specimen in the Peradeniya Herbarium, from the Botanic Gardens, Peradeniya in 1899. The European nettle, *Urtica dioica* Linn., is established (February, 1923), at Nuwara Eliya.——T. Petch.

Vernacular names. *Marsilea quadrifolia* L. has been sent in from the Southern Province under the name Peti-pala. *Litsea fuscata* Thw. was received from the Haputale district as Kudukurundu, which is the Sinhalese name of *Cinnamomum litseaefolium* Thw. *Eryngium foetidum* Linn. was sent in under the Sinhalese name Andu. Mr. F. Lewis records the Sinhalese name Berendiya for *Tournefortia argentea* L. f. in the Tangalle district, and Gal-nawa for *Sterculia Thwaitesii* Mast. in both the North Western and the Southern Provinces. Mal-weralu has been recorded for *Elaeocarpus montanus* Thw. in the Haputale district; Weralu is a generic name for Elaeocarpus. *Albizzia amara* Boiv. was given the Sinhalese name Iha in the Haragam district. A narrow-leaved

form of *Alangium Lamarckii* Thwaites was sent in as a specific for hydrophobia under the Sinhalese name Ruk-anguna. *Indigofera galegoides* DC. was received from the Matale district under the Sinhalese name Weliweriya ; this may be a corruption of Wal-awari, the name applied to *Indigofera trita* L.f. *Hydnocarpus venenata* Gaertn. was sent in from the Galle district under the Sinhalese name Makitiya. A report having been received that the young fronds of the "Australian fern" were used as food, specimens were obtained and were found to be *Nephrolepsis exaltata* (L.) Schott.—T. Petch.

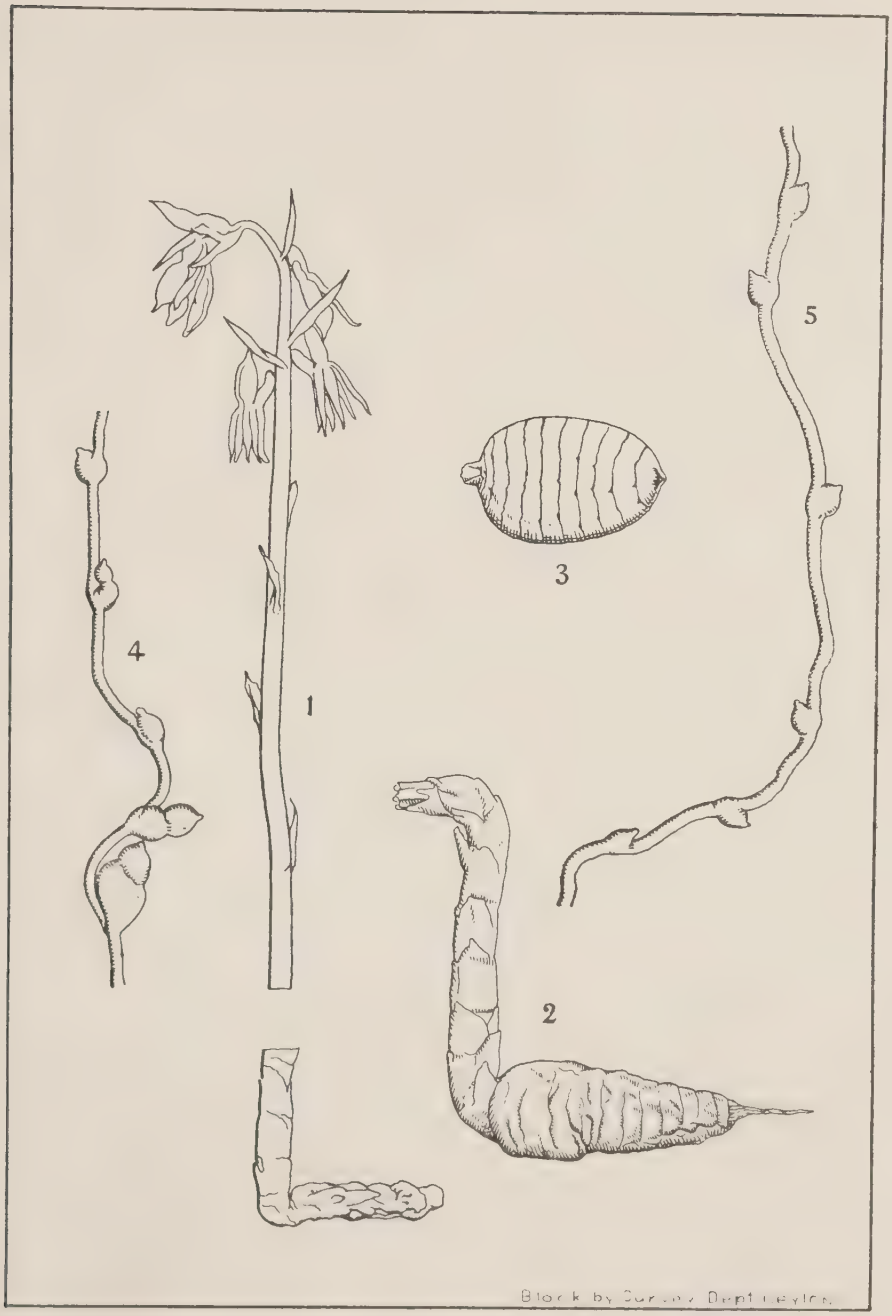
Coleus Rehneltianus A. Berger. This plant was collected by Rehnelt at Anuradhapura about 1913, and seeds were subsequently distributed. In 1921, it was in cultivation at Kew, and was recognised as having been grown for many years in the Royal Botanic Gardens, Peradeniya. It has since been determined at Kew as *Coleus pumilus* Blanco. The date of its introduction to Peradeniya is not known. As the Hotel grounds at Anuradhapura were formerly a branch Botanic Garden, there seemed a possibility that the plant had been originally sent from Peradeniya and had survived the abandonment of the garden or had persisted as an escape. It is not, however, growing in the grounds now, and it is improbable that it could ever have survived there untended. It is more likely that the plant was collected from pots on the hotel verandah.—T. Petch.

Vanda Roxburghii Br. A "pink" form of this species has been known for many years,and is to be found especially in the neighbourhood of Madu Road. Mr. G. B. Foote collected another colour variety at Damboul in 1924, in which the flower is yellow. The three known colour forms of this species in Ceylon are as follows :—

Normal form. Sepals and petals greenish grey with a very narrow paler margin, tesselated with slaty grey lines ; mid-lobe of lip bright blue ; column, and internal face of lateral lobes of lip bluish white, sprinkled with minute blue spots.

Pink form. Sepals and petals pinkish brown, tesselated with darker brown lines ; lip red-purple ; column white, with small purple spots on the back.

Yellow form. Sepals and petals yellow to greenish yellow, not tesselated except structurally when the flower is old ; lip purplish rose, somewhat brownish above, the two lobes of the lip rather larger and more divergent than in the normal form ; column and lateral lobes of the lip pale yellow, not spotted ; two small triangular areas, minutely spotted brown, at the base of the lip, just below its junction with the column.—T. Petch.



Epipogon nutans

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